TRANSACTIONS

OF

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS

VOL. X.

TENTH ANNUAL MEETING

NEW YORK, JANUARY 19-21, 1904

SUMMER MEETING

DETROIT, MICH., JULY 15-16, 1904

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CONTENTS.

CHAPTER		PAGE
CXIX.	PROCEEDINGS OF TENTH ANNUAL MEETING...	7
	PRESIDENT'S ADDRESS.....	8
	REPORTS OF OFFICERS.....	10
	REPORT OF COMMITTEE ON UNIFORM CONTRACTS.	15
	REPORT OF COMMITTEE ON TENTH ANNIVERSARY.	16
	REPORT OF COMMITTEE ON COMPULSORY LEGISLATION	22
	REPORT OF COMMITTEE ON TESTS.....	26
	PAPERS OF THE ANNUAL MEETING.....	33
CXX.	A SHORT HISTORY OF OUR SOCIETY, BY S. A. JELLETT	35
CXXI.	A REVIEW OF SOME HEATING LITERATURE, BY HUGH J. BARRON.....	48
CXXII.	DESCRIPTION OF HOT-WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION, COPENHAGEN, DENMARK, BY CAPT. A. B. RECK..	55
CXXIII.	THE METRIC SYSTEM, BY CHARLES F. HAUSS..	80
CXXIV.	TEST OF A HOT-AIR HEATING APPARATUS USING RADIATORS INSTEAD OF REGISTERS, BY GEO. M. AYLESWORTH, M.D.....	101
CXXV.	TO FIGURE HEATING WORK ACCURATELY—TABLE SHOWING THE LOSSES IN BRITISH THERMAL UNITS FOR VARIOUS SURFACES, BY CHARLES F. HAUSS.....	114
CXXVI.	THE NECESSITY OF MOISTURE IN HEATED HOUSES, BY R. C. CARPENTER.....	129
CXXVII.	THE BATTERY SYSTEM OF WARM-AIR HEATING, BY C. E. OLDACRE.....	137
CXXVIII.	TOPICAL DISCUSSIONS:	
	PRESERVATION OF RECORDS.....	162
	RELATIONS BETWEEN ENGINEERS AND MANUFACTURERS	169
	PROPORTIONING AREAS OF AIR DUCTS.....	170

CHAPTER		PAGE
	Proportioning Water Heaters in Hot-air Furnaces	172
	Cast-iron Boilers for Steam Heating	175
	Durability of Iron and Steel Pipe	176
	Sizes of Pipe for Greenhouse Heating	177
	Need of Ventilation in Heated Buildings	183
	Best Method of Making Screwed Joints	198
CXXIX.	Proceedings of the Semi-annual Meeting, Detroit, Mich., July 15-16, 1904	209
CXXX.	A Review of Some Heating Literature, by Hugh J. Barron	216
CXXXI.	The Education of Heating and Ventilating Engineers, by Jas. D. Hoffman	222
CXXXII.	Advanced Methods of Warm-air Heating, by A. O. Jones	235
CXXXIII.	Topical Discussions, Semi-annual Meeting:	
	Vacuum Systems of Steam Heating	255
	Effect of Humidity in Rooms	264
	Prices for Services by Engineers	270
	Discussion of the Plenum System in England	274
	Benefits of Fan Over Gravity System	282
	Changing the Air in a Room	285
	Supplementing Direct Radiation by Fan System	286
	Index	301

CXIX.

PROCEEDINGS OF THE TENTH ANNUAL MEETING

OF THE

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

HELD IN THE HALL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

12 West Thirty-first Street, New York City,

January 19, 20, 21, 1904.

First Session.

The meeting was called to order by President H. D. Crane at 2.30 P.M. Secretary Mackay called the roll and reported that a quorum was present.

The Secretary read the list of names of members elected since the last meeting, as follows:

NEWLY ELECTED MEMBERS.

Ernest J. Brooks . . .	New York
R. R. M. Carpenter . .	Philadelphia, Pa.
Henry M. Carruthers . .	East Boston, Mass.
George W. Clark . . .	New York
Fred W. Clegg	Louisville, Ky.
B. S. Harrison	New York.
Jas. D. Hoffman . . .	Lafayette, Ind.
A. M. Feldman . . .	New York
J. E. McGinness . . .	Pittsburgh, Pa.

Edward S. Mobley . .	Westminster, Md.
H. W. E. Muellenbach .	Hamburg, Germany
Millard P. Osbourn . .	Camden, N. J.
Harry A. Robinson . .	Chicago, Ill.
John P. Schaffer . . .	Pittsburgh, Pa.
Kunisuke Sekido . . .	Tokio, Japan
William G. Snow . . .	Philadelphia, Pa.
Robt. A. Widdicombe .	Chicago, Ill.
Frank J. Corbett (associate)	New York

The President then addressed the meeting as follows:

PRESIDENT'S ADDRESS.

To the Members and Guests of the American Society of Heating and Ventilating Engineers:

Gentlemen: It is my pleasure to bid you welcome to-day to this, our tenth annual convention, and I hope that the members and our guests will feel free to discuss all the stated subjects under consideration and will introduce any new ones that may be suggested to their minds, or that they have met with in their experiences at home, thus making this meeting fulfill the object of our annual gatherings, " Information and Improvement in Our Profession."

Truly " Time's noblest offering is her last," and we are most happy to-day in the possession, at last, of an association to which it is an honor to belong, not only because it is recognized throughout the heating and ventilating engineering world as the originator of nearly all of the available literature printed in the English language on this subject, but because it enrolls in its membership almost all of the brightest minds in the world working on this line.

This high position for our Society was not accomplished without many discouraging periods, but by herculean work and faithfulness by all the members and the officers so wisely elected in the past to the objects and principles aimed at by the originators of the Association a great success has been scored, and to-day we find it a substantial reality, which will survive, because the members have learned of its great personal benefits. Every member has contributed his part in

attaining this distinction and consideration, but I wish to make special mention of the faithfulness and unselfish devotion of our worthy Secretary, Mr. W. M. Mackay. It is due this gentleman that the members should know that he was one of the Charter members and has served the Society, either as one of the Board of Managers, or as its Secretary, ever since its organization in the summer of 1894. He has given to the Society much of his valuable time and in a quiet, unassuming manner has intelligently handled the affairs of his office, reflecting credit upon the association and maintaining its dignity.

The continued success of our Society depends upon the willingness of the members to contribute topics for discussion and papers describing jobs in practical operation. A most valuable and interesting paper can be prepared by the humblest member of our society, who has a number of heating jobs working, for no two buildings or requirements are alike, and either some new feature is introduced or a combination of old ones resorted to, which contribute to the success of the plant. We are all anxious for practical knowledge and such papers as I suggest will give it to us or suggest new lines of thought.

In looking over the printed transactions of our Association, I note that but little has been said or written upon the subject of heating and ventilation through the medium of the hot-air furnace. We have among our numbers gentlemen who have had the experience and possess the knowledge and brains to advance this profession on the lines of scientific heating and ventilation and who can, if they will, lift it above the plane of a purely commercial basis. More papers, more discussions in the Society meetings, are what is needed, and I would recommend to the incoming Board of Governors that they make a special effort to secure full and comprehensive papers and discussions upon this subject at our next summer meeting.

It is the duty of your Board of Governors to maintain the standard of membership of this Society and see that no one enters who is not worthy and fully qualified. I quote the words of your first President, Mr. E. P. Bates, which fully meet the requirements: "I now charge you, as you love the cause in which you have so recently launched your bark, to look well to your applications for membership, as the growth and prosperity of this Society rests upon this fully as much as any proposition."

On the walls of a palace in Europe, I am told, hang two pictures side by side; one represents a youth in the pride of his manhood cleaving his way through a virgin forest; the other that of an old man, bent with age, leaning over a casket containing the golden glories of his past and of his good name. Both pictures are labeled " Progress." So, gentlemen, will the Society of Heating and Ventilating Engineers progress; first, by firmly and steadfastly endeavoring to increase the usefulness of its work; and, second, by remembering to carefully maintain the standard of its membership.

In conclusion, I would ask that every member does his duty in a combined effort to increase the usefulness of this Society; then all the achievements of the past will be but the beginning of a future surpassing our fondest hopes. Looking back ten years, we may to-day cast our eyes forward with confidence. Our Society, which we love so well, in the years that are to come shall still more increase and flourish like a plant of perennial bloom.

The President: We have now to hear the report of the Secretary.

The Secretary read his report as follows:

SECRETARY'S REPORT.

Gentlemen: Your Secretary would report an increase in membership during the past year. At our last annual meeting our membership was composed of 156 members, 1 Honorary member, 12 Associates and 5 Juniors, or a total of 174 members of all grades. During the year we have added 30 members and 4 Associates, one Associate member has been reinstated, two Associate members have been advanced to full membership, two Junior members have been advanced to full membership, and one Associate member failed to qualify; four members have been dropped from the roll for non-payment of dues and one member, Mr. A. H. Fowler, died June 3, 1903. Our present membership is 185 members, one Honorary member, 15 Associates and 3 Juniors, or a total of 203 members of all grades, making a net increase of 29 during the past year, in addition to which we have a number of applications to be acted on and voted on after the annual meeting.

The financial affairs of the Society are in good condition. At the last annual meeting there was a balance in the hands of the Treasurer of $453.69. We have received from all sources during the past year $2,423.93, which, with the balance on hand, made a total of $2,877.62 available.

The expenditures amounted to $2,334.13, leaving a balance in the hands of the Treasurer of $543.49.

There is a balance owing from members for dues and from newly elected candidates for membership for initiation fees and dues and for Proceedings amounting to $490; this, with the balance on hand, amounts to $1,033.49.

We have no unpaid bills except those in connection with the present meeting, which have not been presented, and the Secretary's account, amounting to $40.56, so that, deducting this, with the amount on hand and owing from members and others, leaves a balance of $992.93.

The members dropped from the rolls during the year owed the Society a total of $140.

The Secretary's expenses for the year, including stenographer, clerk hire, rent of post-office box, expenses in connection with the summer meeting, postage, 12 tin-lined boxes for the Proceedings on hand, expressage, etc., amount to $530.58.

The 1903 Proceedings have been edited and printed, they are now being corrected and bound, and will be forwarded to the members during the month of February. The cost of the editing and printing of these Proceedings will amount to about $800.

The Society held a successful meeting at Niagara Falls, N. Y., July 17 and 18, 1903.

All the papers to be presented at this meeting, with the exception of two, which will be read from manuscript, while received late, have been printed and forwarded to the members.

Respectfully submitted,

W. M. MACKAY, Secretary.

On motion, the report was received and placed on file.

The President: The report of the Treasurer is next in order.

The Secretary then read the Treasurer's report, as follows:

New York, January 19, 1904.

Gentlemen: Your Treasurer begs to submit the following report:

Balance on hand Jan. 21, 1903		$453 69	
Cash received since Jan. 21, 1903:			
Pin badges	$9 00		
Electrotypes	43 73		
Proceedings	26 00		
Subscription to deficiency fund	15 00		
Initiation fees	425 00		
Dues	1,905 20	$2,423 93	
			$2,877 62
Disbursements for the Society:			
Treasurer—collections, stamps, etc		$2 28	
Secretary's account, 1902		45 06	
Mechanical Engineers' rooms		65 00	
Stenographer, annual meeting		176 25	
Certificates of membership		49 75	
Bormay & Co., cuts		128 41	
Schoen & Kellerman, printing		154 60	
Editing 1902 Proceedings		100 00	
Stenographer, summer meeting		146 75	
J. J. Little, advance papers, annual mtg.		46 75	
J. J. Little, 1902 Proceedings		611 34	
J. J. Little, Constitution and By-Laws		103 17	
J. J. Little, uniform contracts		15 50	
J. J. Little, advance papers, summer mtg.		24 25	
Secretary's services, 1903		150 00	
Secretary's account, 1903		490 02	
J. P. Pritchard, legal fees		25 00	$2,334 13
Balance in Washington Trust Co			$543 49

Respectfully submitted,

J. A. GOODRICH, Treasurer.

On motion, duly seconded, the report was received and placed on file.

Mr. A. E. Kenrick then read the report of the Board of Governors, as follows:

REPORT OF BOARD OF GOVERNORS.

New York, January 19, 1904.

Gentlemen: Your Board of Governors met and organized January 22, 1903, appointing a Committee on Finance, Membership and Publication. The various committees have given careful attention to their duties and the Board has met as often as was found necessary during the year.

We are able to report an increase in membership and the financial affairs of the Society are in good condition, with sufficient funds on hand to pay for the publication of the 1903 volume, which has just been printed, and which will be forwarded to the members during the month of February.

According to resolution at the last annual meeting, the Board of Governors met and revised such parts of the By-Laws as were complained of at the last annual meeting, sending out a letter ballot to the members. Sixty-eight votes were cast, 64 being in favor of and 4 against the amendments, which were adopted.

According to resolution at the last annual and summer meetings, your Board of Governors have carefully considered the advisability of organizing local chapters of the Society in different sections of the country. After due consideration it was decided that on account of our limited membership and the few points where sufficient members could be got together to make it a success, that we report against the question of local chapters at this time.

According to resolution at the summer meeting, a vote by letter ballot was taken on the Metric system, 80 votes being cast out of a total voting membership of 168. On the first proposition there were 34 votes "in favor of the adoption of the Metric system of weights and measures as the legal standard of the United States" and 45 against. On the second proposition there were 37 votes "in favor of the adoption of the Metric system in the Departments of the Federal Government" and 42 against. On the third proposition there were 41 votes "in favor of legislation which would promote the

adoption of the Metric system" and 39 against. From this it will be seen that the first proposition was lost by 11 votes, the second proposition by 5 votes, while the third proposition was carried by 2 votes.

Your Board of Governors has been in communication with the Carnegie Institute, Washington, D. C., regarding research in connection with heating and ventilation. Suggestions have been made to the Institute and its officers are now considering these suggestions with a possibility of favorable results.

A revision of the Constitution and By-Laws with a revised list of members will be published and forwarded to the members after this meeting.

A summer meeting was arranged for July 17 and 18, 1903, at Niagara Falls, N. Y., which proved successful in every way.

Rspectfully submitted,

H. D. CRANE, Chairman;
C. B. J. SNYDER, Vice-Chairman;
A. E. KENRICK,
R. C. CARPENTER,
JOHN GORMLY,
GEO. MEHRING,
W. M. MACKAY, Secretary.

On motion, the report was received and placed on file.

The President: The Standing Committees will now be called upon to make reports. Mr. Snyder is Chairman of the Committee on Compulsory Legislation, but he does not appear to be present.

The Secretary: I make the motion that the reports of all the Committees whose Chairmen are not here be laid over for the present.

Motion seconded and carried.

The Secretary: There is a Standing Committee which does not appear on the programme, that on Uniform Contracts, of which Mr. Jellett, who is present, is Chairman. They finished their labors last November, and I suppose it would be wise at this time to have Mr. Jellett hand in the report.

Mr. Stewart A. Jellett then read the report as follows:

REPORT ON UNIFORM CONTRACT.

New York, January 19, 1904.

Gentlemen: At the last annual meeting of our Association the Committee made its report on Uniform Contract and General Conditions governing the specifications, and submitted a form for same which was accepted by the Society, and the Secretary was instructed to send out copies of the proposed form to all members of the Society, with the request that they send to the Committee any suggestions or criticisms they had to make, and that when these suggestions and criticisms were received the Committee should then go over the proposed Form of Contract and General Conditions and consider the suggestions made and make any modifications that they felt would improve it. After this was done the matter was to be brought before the National Association of Steam and Hot Water Fitters for their consideration, with the request that if they approved that their name should also appear on the printed forms that would later be sent out, so that the approval of both the Master Steam Fitters and our Society should appear.

The Committee beg to report that they received a number of suggestions, gave them their careful consideration, and as a result made a number of changes and modifications in the proposed form, and final corrected copy has been sent to all members by the Secretary, and the matter was brought before the last Convention of the Master Steam and Hot Water Fitters in Washington, and a resolution was passed at that Convention that the members of the Master Steam and Hot Water Fitters' Association give consideration to the Form proposed by the American Society of Heating and Ventilating Engineers, and that copies be sent to all members for their consideration and that upon receipt of a favorable reply from the members their Board of Directors should approve of same.

Copies of the revised form have been sent out to the Master Steam and Hot Water Fitters' Association, and by them to their members throughout the country, but up to the present writing we have no official decision from their Board of Directors.

Your Committee would make this as their final report and would ask, therefore, in view of the fact that they have com-

pleted their labors, that they be discharged from further consideration in this matter.

Very truly yours,

S. A. JELLETT, Chairman.

Mr. Andrew Harvey: I move that the report be accepted and referred to the Board of Governors and that the Committee be discharged. Seconded and carried.

The President then appointed as Tellers: Mr. H. A. Smith, Mr. H. J. Barron, and Mr. H. L. Anness.

The President: We will now take fifteen minutes recess, and if any one comes in in the meantime that has not voted, he will have an opportunity to do so.

Recess of fifteen minutes.

The President: The next order of business is New Business.

Mr. Andrew Harvey: I don't know whether it is in order now to say anything about the summer meeting.

The President: I presume that would be considered as new business. Have you anything to suggest?

Mr. Harvey: I would simply suggest that if the Society sees fit to come to Detroit, I will guarantee that they will have as pleasant a time as they could get in any city in the country. And I will also state that if they want to go to the St. Louis Exposition from that point, it is practically the same as going to Chicago, and they can go in one night. I speak of it simply to bring it before this meeting, Mr. President, and would move that the Board of Governors be requested to arrange that the summer meeting be held in Detroit this summer.

Seconded by Mr. A. H. Smith and carried.

The President: We have a report that we can hear at this time from Mr. Harvey of the Tenth Anniversary Committee.

Mr. Harvey then read the report as follows:

THE REPORT OF THE TENTH ANNIVERSARY COMMITTEE.

At the annual meeting of the American Society of Heating and Ventilating Engineers two years ago, as the result of a motion to celebrate the Tenth Anniversary of the Society, a Committee was appointed to aid the officers and Board of

Governors in carrying the idea into effect. The Committee in this report has no intention of going into details as to all that has been done, but congratulates the Society that as the result of its work a decided impetus has been given to the welfare of the Society as reflected in the largest membership the Society has ever enjoyed, and increased interest in the annual meetings, also the summer meetings. Possibly the principal work done has been to explain to the profession the valuable service which this Society has rendered. This knowledge of an organized body working to a commendable end has secured the attention of those broad-minded and ambitious engineers who desire to participate in the excellent work. The first work done by the Committee was at the summer meeting at Atlantic City, eighteen months ago, and really was in the nature of an explanation of the objects of the Society, its method of working, and what it had accomplished. This work was supplemented at the annual meeting a year ago, and again at the summer meeting last year at Niagara Falls. If this Committee has done no other work, it is a substantial achievement to report that the tendency among men in this profession which obtained a few years ago of cherishing their experience as valuable personal secrets has been superseded by a liberality in the exchange of valuable experience, and is in itself an achievement of which the Society can well be proud. The Committee is willing to report that many of its aims and ambitions have not been accomplished, and is, as a result of its work and experience, strongly convinced that the archives of the Society should contain descriptions of all kinds of heating and ventilating plants that would make a valuable history of the art, and an invaluable collection of data for a reference by engineers who have been devoted to one branch, and who have calls made upon them to design systems in another branch of the profession.

The Committee has induced some of our members to present the interesting papers which will contribute substantially to the entertainment and value of this meeting. It has worked in connection and coöperation with the Board of Governors and the Secretary, and had the support of all the officers. The Committee desires to thank the Secretary for his ever ready assistance, the Board of Governors for the support of their efforts, the officers for their encouragement, and the members

for the work that they have done in making the tenth annual meeting an anniversary one which, when it closes, will, we feel certain, be one of the most beneficial in the history of the Society.

It is the intention of the Committee to assist in entertaining the members and guests at this meeting, and hope that our report will be accepted and the Committee discharged at the close of the meeting.

ANDREW HARVEY, Chairman.

On motion, duly seconded, the report was received and placed on file, and the thanks of the Society were extended to the Committee.

The President: No other business being brought before the meeting, we will proceed to take up the Topical Discussions. There has been a suggestion made that we start in with the thirteenth topic, "In making screwed joints is it better to use some compound or make them up with iron with no compound?"

The topic was discussed by Messrs. Barron, Cary, Kenrick, Lyman, Paul, Joslin, and President Crane.

The President: We will proceed now to the consideration of topic No. 12: "Has the need been demonstrated of some method of ventilation in connection with accepted systems of heating?" The subject is now open for discussion.

The topic was discussed by Messrs. Cary, Joslin, Chew, Bernhard, Berry, Lyman, Barron, Reck, Kenrick, Blackmore and Hosford.

On motion, duly seconded, the meeting adjourned for the evening session, at 8 o'clock P.M.

EVENING SESSION.

Tuesday, January 19, 1904.

The meeting was called to order at 8.20 P.M.

The President: We will take up the business of the evening session of the first day and hear the report of the Tellers of Election.

Mr. Smith read the report of the Tellers as follows:

New York, January 19, 1904.

The Tellers report the following result of the ballot:

Total votes cast 104

President:

Andrew Harvey . . .	68	William Kent	35

First Vice-President:

John Gormly	65	R. P. Bolton	38

Second Vice-President:

R. C. Clarkson	64	John Hopson	38

Secretary:

W. M. Mackay	98	P. H. Seward	6

Treasurer:

U. G. Scollay	76	F. P. Blodgett	28

Board of Governors:

R. C. Carpenter . . .	88	Geo. Mehring	46
A. E. Kenrick	78	Thos. Barwick	34
C. B. J. Snyder	75	H. A. Joslin	24
H. D. Crane	73	C. E. Oldacre . . .	22
J. J. Blackmore	49	Richard Hankin . . .	19

Respectfully submitted,

H. A. SMITH,
H. J. BARRON,
H. L. ANNESS.

The President: We will now have the reading of the paper, "A Short History of Our Society," by Stewart A. Jellett, member of the Society.

Mr. Jellett: Mr. President and Gentlemen—It was thought by the Committee on the Tenth Anniversary that it might be

a good thing to have a short history of the Society for this meeting, as a great many members of the Society who have joined in recent years knew but little of the early days. That is why this brief history is written.

Mr. Jellett then read the paper, which is printed elsewhere in this volume.

The President: This paper is scheduled for discussion. Are there any remarks to be made upon the paper, or any questions to be asked? Not hearing any we will proceed to the topics for discussion:

No. 1. "Should it be considered the work of the Society to secure and preserve records in detail of the different types of heating systems in different types of buildings?"

The topic was discussed by Messrs. Wolfe, Jellett, Chew, Meyer, Kinealy, Barron, Snow, Smith, McKiever and Secretary Mackay.

The President: We will now take the second topic:

No. 2. "Could the interests of the purchaser of heating systems be conserved by a closer relation between the heating engineer and the manufacturer of apparatus?"

The topic was discussed by Messrs. Barron, Lyman, Chew and Davis.

The President: Is there any further discussion? If not, we will proceed to No. 3:

"The relative advantage of low pressure and vacuum systems for small work in residences, etc."

The topic was laid over for discussion at another time.

The President: If it is the pleasure of the Society, we will now take up topic No. 11. It is:

"Has latest practice demonstrated the advisability of using smaller sizes of pipe in hot water heating systems in greenhouses?"

The topic was discussed by Prof. Carpenter, Capt. Reck, Secretary Mackay and Messrs. Chew, Bernhard and Barron.

The President: It is moved and seconded that we adjourn to meet to-morrow afternoon at 2. But before putting that question I wish to call your attention to the fact that the Society is to be congratulated on the presence among us of a foreign member, Captain A. B. Reck, of Copenhagen, Denmark, who has timed his visit to the United States so as to

attend this convention and this meeting, and he will read a paper to-morrow. This is the first time we have had any of our foreign members with us who have read papers. Some of them have sent papers to us.

Mr. Wolfe: I move that we welcome the member by a rising vote.

It is moved and seconded that we honor the foreign member with a rising vote. All those in favor will indicate it by rising. It is unanimous. You are welcome, sir, by a rising vote.

The meeting then adjourned.

Second Day.

AFTERNOON SESSION.

Wednesday, January 20, 1904.

The meeting was called to order by President H. D. Crane at 2.30 P.M.

Mr. Barron then read a paper entitled, "A Review of Some Heating Literature."

The paper was discussed by Messrs. Barron and Kenrick.

Mr. Wolfe: I move that the recommendations made by Mr. Barron in his paper be referred to the Board of Governors, in view of the discussion last night, and that the Society collect all technical literature possible on the subject and either embody it in our annual book or put it in some permanent form.

Motion seconded, put to a vote, and carried.

The President: If there is no further discussion, we will proceed to the next paper. I would like to state to the Society that the next paper was prepared at the special request of the Executive Committee of this Society. Feeling that there was instruction in it, and that a paper upon this subject would certainly benefit all of us, when we heard that Captain Reck was coming to this country we asked him to so time his visit here that he could be with us, and prepare a paper to read upon a subject that he has fitted himself so carefully to treat by practical work and by study. Gentlemen, I introduce to you Captain Reck, of Copenhagen, Denmark.

Captain Anders B. Reck then read a paper entitled: "Description of Hot Water Heating Aparatus in Schioldann Institute, Copenhagen, Denmark."

The paper was discussed by Messrs. Joslin, Kinealy, Barron, Barwick, Davis, Paul, Snow, Lyman, Mehring, Blackmore and James Mackay.

The President: We will now take up the next paper, "The Metric System," by Charles Hauss, a member of the Society. This will be read by Professor Kinealy, as Mr. Hauss is not present.

Professor Kinealy: I read this paper for the author, but I do not want you to infer that from my reading it I endorse all that it says.

Professor Kinealy then read a paper on the Metric System, by Charles S. Hauss, Antwerp, Belgium.

The paper was discussed by Messrs. Chew, Blackmore, Barron, Kinealy, Harvey, Snow, Baldwin and Reck.

On motion, the meeting adjourned until Thursday morning at 10.30 o'clock.

Third Day.

MORNING SESSION.

Thursday, January 21, 1904.

The meeting was called to order by President H. B. Crane at 11 o'clock.

Mr. B. H. Carpenter read the report of the Committee on Compulsory Legislation, as follows:

REPORT OF COMMITTEE ON COMPULSORY LEGISLATION.

To the American Society of Heating and Ventilating Engineers:

Gentlemen: Your Committee has made not a little effort with regard to the adoption by various States of laws regarding sanitation, which would also include requirements of proper ventilation in public buildings and public schoolhouses. There has been, thus far, no specific result, other than to clear the atmosphere somewhat, and point to the only method by which the desired result can be accomplished.

Mr. B. H. Carpenter, a member of the Committee, has taken up the question with the members of the Pennsylvania Legislature. Some quotations from the letters received by him are of great interest to this Society, and we therefore venture to

quote same: Senator Wagoner stated that the bill forwarded by Mr. Carpenter was apparently snowed under in the Senate Committee on Sanitation and Public Health; further, that Pennsylvania has, he regrets to say, so far as its Legislature is concerned, the least concern for its public health of any State or Territory in the Union; it it a shame and a disgrace. He stated also that the members of the Committee of the Associated Health Authorities and the sanitarians of the State would coöperate with Mr. Carpenter in the passage of the law; that the annual meeting of the Associated Health Authorities and the Sanitarians of Pennsylvania would be held in Harrisburg on a given date, and that the meeting would call together a legislative committee representing fifty senatorial districts of the State before concerted action could be had looking to further important legislation in behalf of better sanitary laws of the State. Mr. Carpenter attended the meeting, but, unfortunately, Senator Wagoner was unable to be present. Directing his endeavors to have a hearing, the following proposition was made very clear to him: that before any action could be taken in the matter it was necessary that the Legislative Committee be informed of what previous legislative enactments touching this subject were already upon the statute books. This naturally means that the attention of a legal firm will be necessary to take care of the subject.

In the State of New York, as reported last year, a bill was sent on to the Superintendent of Schools in Albany, whose wide acquaintance with the educational authorities who had pledged themselves to support the bill promised success. The unfortunate controversy, however, which arose between the State Superintendents of Departments and the Board of Regents prevented any action being taken.

This year the bill was sent to Albany about three weeks prior to the beginning of the legislative session, and on January 8th we were informed that the bill had been submitted on the 7th inst. to Mr. C. W. Meade, Assemblyman of Albany County, who agreed to see that the bill was introduced. The bill was made to apply to cities of the third class and to incorporated villages, as in cities of the first and second class the provisions of the bill are already being observed. Later it was found that Mr. Meade did not think it would be well for him to intro-

duce the bill, as he represented a district containing cities of the second class, but it was to be introduced by one of two other men, whose names were given. Not hearing anything in a few days, he was written to on the 15th for information, and this morning there was received a letter stating that the bill has not yet been introduced, but that it will be, as before promised, within a day or so by the Albany delegation, and that should they decline to take charge of the bill, Mr. Cole would consult us immediately as to what should be done. He says in his communication that the bill is an important and far-reaching one, and as it applies to cities of the third class and incorporated villages, it would seem imperative that it should be introduced by a representative of such locality.

The bill, at the present time, is receiving quite wide circulation through its publication in a little hand-book entitled, "School Architecture. Handy Manual for Architects and School Authorities," which has been compiled by Mr. William George Bruce, editor of the "School Board Journal," and published and distributed by a firm which makes certain appliances which engineers apparently deem essential for successful mechanical ventilation. The bill is printed in its entirety, the page being headed, "Law of Schoolhouse Construction," and the first paragraph containing the sentence, "Its strict observance in the construction of school buildings is strongly recommended." The distribution of the bill in this shape cannot be otherwise than beneficial.

Your Committee made efforts in other directions, without any greater success than above noted, and it is therefore unnecessary to discuss them in detail. From the work gone through, however, we would draw the following conclusion: That compulsory legislation is not to be obtained without the retention of some firm of attorneys who make legislative business a specialty, and who can follow up every move necessary to be made.

C. B. J. Snyder,
Andrew Harvey,
B. H. Carpenter,
Henry Adams,
T. J. Waters,
Committee on Compulsory Legislation.

Mr. B. H. Carpenter: I might add that, though I have bills that have been presented in the New York Legislature, and bills that have been gotten up in our own State, the legislators would have nothing to do with the bill. They said it would be no use trying to present it until we had all the data regarding the laws that have been passed in the past. As that would require a great many years, and necessitate the reading of a great many books, it was a big job, and I naturally gave it up at that point. I had a personal friend in Harrisburg, also a member of the Senate, who said that if we could get things together he would gladly frame the law, and would do anything he could in reason, but I could not ask him to do all that work.

On motion of Mr. Chew, duly seconded, the report was accepted and placed on file.

The President: I would like to have a report from the Committee of which Professor Kinealy is a member, the Committee on Standards.

Professor Kinealy: The Committee has only a verbal report to make. The special work referred to the Committee last year was in connection with Mr. Blackmore's paper on the rating of boilers. We had to wait until almost the beginning of this year in order to get a copy of the discussions at the last meeting. We wanted the discussion in full, and such suggestions as were given by the members during the discussion. The result was that we have not made any material progress with this work, and we can only report that the matter has been taken up and that it will be worked out during the coming year. I have also spoken to the president of the Carbon Club, and the Carbon Club will coöperate with us; that is to say, the club has taken some steps in this matter, and they will allow us to use some of their data, which will help us in a way.

The President: We will proceed to the papers for the third day's proceedings, and we will listen to the reading of the paper contributed by a non-member, Dr. G. M. Aylesworth, at the request of the Society. The Doctor will be kind enough to step forward now and read his paper.

Dr. G. M. Aylesworth then read the paper referred to, entitled, " Test of a Hot Air Heating Apparatus, Using Radiators Instead of Registers."

The paper was discussed by Messrs. Kent, Barron, B. H.

Carpenter, Joslin, Kenrick, Wolfe, Richardson, Snow, Berry, Chew and Eckfeld.

The President: Have you finished the discussion on this paper? As I hear no response, I will close this discussion, and we will proceed to the reading of the next paper, "To Figure Heating Work Accurately—with a Table Showing the Losses in British Thermal Units for Various Surfaces." By Charles F. Hauss, Antwerp, Belgium. Mr. Hauss is a member of the Society, but he is not present. Will Professor Kent be kind enough to read the paper?

Professor Kent then read the paper referred to.

The paper was discussed by Messrs. Feldman, Kent, Kinealy, Snow, Barron, Oldacre, Chew, Joslin, Wolfe, Richardson and Davis.

At the close of the discussion, on motion of Mr. Chew, the question of the value of extended surface was referred to the Committee on Tests.

On motion, the Society took a recess until 2 o'clock P.M. of the same day.

THIRD DAY.

AFTERNOON SESSION.

Thursday, January 21, 1904.

The meeting was called to order by President H. B. Crane at 2.30 o'clock.

The President: Is the Committee on Tests ready to report?

REPORT OF THE COMMITTEE ON TESTS.

Professor Carpenter: I have no formal report to make regarding Tests, but I wish to lay before the Society some of the matters which have come to my attention in reference to testing during the year. I have made during the year, in connection with the University work, a large number of tests with radiators, which is along the line of the work suggested for the Committee. Those tests, however, were generally made for the purpose of determining the efficiency or capacity of some particular radiator, or for getting data by which the Company making the radiator might be assured that the radiator was

equal to some certain standard form. The results do not seem to be of sufficient general interest to print in detail, as they simply show ordinary and usual results. The results simply show that we get certain values from certain shaped radiators in certain forms and under certain conditions, as already pointed out in my work on Heating and Ventilating. These were of course valuable to the manufacturers of the radiators. These are the only tests which I have conducted or which have been conducted by the Committee on Tests.

I have thought that possibly there might be some question regarding how far the Society could go in committing itself to any work done by any Committee on Tests. The testing is some man's work, regarding which there may be a dispute either as to method or as to result. A dispute is often likely to be the case when there is any competition for high results between two or three different manufacturers. It seems to me that the Society cannot afford to do any testing where there is competition. It cannot afford to act as judge or umpire in any case of that kind; there is no glory in it, and there is certainly little satisfaction in it, and yet there would be a good deal of unpleasant responsibility to assume. I have sometimes wondered what the true object of the Committee could be. The Society set aside something like $150 which could be used by the Committee. We could very properly take up some investigation, and it was, I think, the intention that that sum might be used for such a purpose. It has not, however, seemed to the Committee, especially to the Chairman of the Committee, judicious to use any of that money for any investigation which has been suggested. If there is any investigation which the Society feel ought to be carried out, that money, I think, could be used to very good advantage. I might say in connection with any investigation that our facilities at Cornell University, which are second to none in this country, generally could be used for such purposes without any charge to the Society. There are always, however, incidental expenses in addition to apparatus connected with every test, although such expenses are not likely to be large. There is nothing required for the skilled work of the engineering force in charge. As I have said, the Committee have not felt it judicious to take up any such investigation. The amount at our disposal, $150, is not great, and

probably not sufficient for an extended investigation. Sometimes the expenses of an investigation are serious; and in that case the amount would not go very far.

With this very short and informal statement of the work of the Committee I will conclude my report.

On motion, duly seconded, the report was received and ordered published.

The President: The next thing on the programme is the reading of Professor Carpenter's paper, which was transferred from the second day, "The Necessity of Moisture in Heated Houses," by R. C. Carpenter, member of the Society.

Professor R. C. Carpenter then read the paper.

The President: In view of the fact that we are a little behind time in our schedule, and also that the paper which will follow is very closely connected with this paper of Professor Carpenter's, if there are no objections, I will call for the reading of the next paper, and then discussion on the two papers can be taken up jointly. Are there any objections?

On motion, duly seconded, the Society proceeded to the reading of the next paper.

The President: The next paper is "The Battery System of Warm Air Heating," by C. E. Oldacre, of Philadelphia, Pennsylvania. Mr. Oldacre is a member of this Society.

Mr. C. E. Oldacre then read the paper referred to.

The two papers were then discussed by Messrs. R. R. M. Carpenter, Oldacre, Kent, Chew, Switzer, Wolfe, Richardson, Barron and Snow.

The President: This closes the discussion on the papers. The time has now arrived when I am to inaugurate the officers that were appointed by this Society for the next year. But before leaving the chair as your President, I wish to say to you that during the last year my association with the Society has certainly been one of the most pleasant that it has ever been my experience to enjoy. And I am satisfied that the Society to-day is on such a firm foundation, and has demonstrated so clearly its necessity to the engineering world, that all presidents that you may elect hereafter will certainly consider it one of the highest honors and compliments that could be extended to them. I will appoint as a Committee Mr. Kenrick and Mr. Kent to escort to the rostrum the incoming President.

XUM

The President-elect, Mr. Andrew Harvey, escorted by the Committee, approaches the rostrum.

The President (Mr. H. D. Crane): Mr. Harvey, it gives me pleasure to welcome you here, and I know that in leaving this office in your hands I leave it in good hands, and that it will prosper under your administration.

Are the Board of Governors and the officers present? (Messrs. R. C. Carpenter, Kenrick, Snyder, Crane, J. J. Blackmore advance towards the rostrum.)

The President (addressing the President-elect): Mr. President, these gentlemen have been elected as your assistants for the coming year.

The President (Mr. Andrew Harvey): Gentlemen, I fully appreciate the honor conferred upon me, and with your assistance I will do the best I can to increase the honor and usefulness of this Societly. (Applause.)

The President: Gentlemen, the retiring President informs me that Topic No. 4 of the second day's session has not been taken up yet, and if it is your pleasure we will take up that topic at the present time. The topic for discussion is Topic No. 4, "The Desirability of More Accurate Records as to Temperature and Humidity in Figuring the Requirements for District Heating Systems."

Mr. Kenrick: There was a letter read by the Secretary on that subject, and I think that that subject was practically considered under Topic No. 1. I therefore move that we pass from the consideration of Topic No. 4 to the consideration of Topic No. 5.

Motion seconded and carried.

The President: Topic No. 5 is, "Can a Constant Relation Be Established between the Areas of Cold Air Ducts, Hot Air Flues and the Radiating and Heating Surface in Different Systems of Indirect Heating?" Has any gentleman anything to say on that subject?

The topic was discussed by Messrs. Kent, Kinealy and Reck.

The President: If there is nothing further to be said upon this topic we will take up next Topic No. 6: "What Is the Prevailing Practice in Proportioning Water Heaters in Hot Air Furnaces to the Work to Be Done?"

The topic was discussed by Messrs. Chew, Snow, Switzer and Richardson.

The President: If there is no further discussion on that subject we will pass to the next topic, No. 7, "Are All Types of Sectional Cast Iron Boilers Adapted for Steam Heating?" Has any gentleman anything to say on that subject?

The topic was discussed by Messrs. Smith, Chew, Kent and Reck.

The President: If there is no further discussion on that subject, we will take up the next topic, No. 8, "Has Experience Demonstrated the Relative Superiority of Iron or Steel Pipe as Regards Durability in Heating Systems?"

The topic was discussed by Messrs. Barron, Switzer and Mackay.

The President: If there is nothing further on this subject, we will pass on to the next topic, No. 9, "Has a Percentage of Increased Efficiency Been Established When Fans Are Used in Connection with Radiation from Steam Heaters, Hot Air Furnaces, etc.?" I think that subject was discussed somewhat this morning in reference to fans for furnaces. Is there anything further on that subject that you wish to say? If not, we will pass on to the next topic, No. 10, "Should the Heating Surface Used for Skylights, Bow Windows, etc., in Residences Bear the Same Relation to the Glass as in Greenhouse Heating Systems?"

No discussion took place on these topics.

The President: I will now announce the names of the Standing Committees for the ensuing year.

The President read the names of the Committees as follows:

Compulsory Legislation: C. B. J. Snyder, Chairman; Henry Adams, W. C. Vrooman, T. J. Waters, B. H. Carpenter.

Standards: J. H. Kinealy, Chairman; H. D. Crane, James Mackay, J. J. Blackmore, Wm. G. Snow.

Tests: R. C. Carpenter, Chairman; Wm. Kent, Geo. Mehring, A. A. Cary, B. F. Stangland.

The President: If there is no further business before the meeting a motion to adjourn will now be in order.

On motion of Mr. Kenrick, duly seconded, the meeting then adjourned.

THE SILVER LOVING CUP SHOWN IN THE ENGRAVING WAS PRESENTED TO W. M. MACKAY BY THE MEMBERS OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS AT THE TENTH ANNIVERSARY DINNER IN RECOGNITION OF HIS FIVE YEARS' SERVICE AS SECRETARY.

PAPERS

OF THE

TENTH ANNUAL MEETING,

New York, January 19-21, 1904.

CXX.

A SHORT HISTORY OF OUR SOCIETY.

By S A Jellett.

(Member of the Society.)

We celebrate at this meeting the tenth anniversary of the founding of our Society, and it seems fitting that we should give a few minutes of our time to reminiscences of what the Society has done since its organization, and to consider the road ahead as to its possibilities.

It is always interesting to trace the growth of a spontaneous movement which leads to the birth of an organization having for its object the moral, intellectual, or physical uplifting of the race. As the proper heating and ventilation of our homes, hospitals, schools and other occupied buildings tend to secure better health and greater comfort for their occupants, we can certainly include in the list of such organizations The American Society of Heating and Ventilating Engineers.

Until about 1890 the business of heating and ventilating had been largely based on the most ancient rule known to engineers, the rule of thumb. Why a business of such importance and of such magnitude as the heating and ventilating of buildings had not been placed on a more scientific basis many years earlier, it is not the purpose of this paper to discuss. I believe it was the stress of competition, the commercial side of the business, that finally forced the recognition of the necessity for more scientific consideration, both in regard to the manufacture of the apparatus used and in its application for regular work.

Many master steam fitters, members of the Master Steam

and Hot Water Fitters' National Association, which had been organized in 1889, feeling the need of more information regarding the engineering side of their business, introduced the feature of reading papers on questions of interest at the National Conventions of their Association. As most of those who attended these annual conventions were the men who handled the business matters of their concerns, not the engineering questions, it was their opinion that the conventions were principally for the discussion of business matters, and but scant courtesy was given to the reading of these papers, and practically no discussion followed.

I believe the last meeting at which papers of this kind were presented was that held in New York City in 1894. At this meeting papers were presented by Mr. D. M. Nesbit, of London, England; Mr. E. P. Bates, of Syracuse, N. Y., and Mr. Arthur Walworth, of Boston—all of them able papers which should have received very careful consideration, but they were not given the consideration they merited, and there was but little discussion.

As a result, some of the master fitters present at the Convention who were specially interested in the engineering side of their business became very much disgusted with the manner in which the papers were received. One of them, Mr. Hugh J. Barron, a member of our Society, wrote some comments on the papers presented at this meeting, together with a criticism of the action of the Master Steam Fitters' Association, which was published in "Heating and Ventilation" in the issue of July 15, 1894. The concluding paragraphs of this criticism will, I think, be of interest to our members, and are as follows:

"There was one thing conclusively shown by this Convention, and that was that engineers are in a decided minority; the majority are more anxious about getting work and money than about the mere art of heating. Imagine any other society in the world inviting men to give them the results of their thoughts, and one gentleman actually coming three thousand miles to do so, and then having a resolution passed that, in future, papers must only take ten minutes to read.

"We have lots of time for excursions, but only ten minutes to hear the result of your thoughts.

"The facts are that the majority of American heating and

ventilating engineers are not members of the Master Steam and Hot Water Fitters' Association, and that a majority of the Association are really business men only. These gentlemen cannot appreciate an engineer's feelings in regard to technical matters. It is a pity that there were not at least a thousand present to hear Mr. Nesbit's paper, and to intelligently discuss it, as English societies of engineers would discuss a paper presented to them by an American engineer of equal eminence.

" The technical side will have to come more to the front at National Conventions, the business side being left to the locals, where it belongs, the National Convention to be a grand interchange of views, where all designers, constructors and engineers interested in heating and ventilating can exchange views for the purpose of elevating and ennobling the art which gives them their daily bread."

As a direct result of this critical article the American Society of Heating and Ventilating Engineers came into existence, and to-night we make our best bow and take off our hat to Mr. Hugh J. Barron, who has the honor of being the founder of this Society.

The article from which I have quoted extracts was submitted by Mr. Barron to Mr. L. H. Hart, then the editor of " Heating and Ventilation," who became very much interested in it and discussed with Mr. Barron the idea of forming a society which should give consideration to engineering matters connected with heating and ventilation only.

Mr. Hart then interested Mr. Wm. M. Mackay, our present Secretary, and together Messrs. Barron, Hart and Mackay worked up sufficient interest among men in the heating and ventilating business in New York City to bring together sixteen of them at a meeting held in Mr. Hart's office in the World Building on August 2, 1894. You will note that this meeting was held within three weeks after the publication of Mr. Barron's critical article in " Heating and Ventilation."

At this meeting in Mr. Hart's office the feasibility of organizing a society of heating and ventilating engineers was very carefully discussed, and before adjournment the following paper was drawn up and signed:

" We, the undersigned, agree to become members of a society of heating and ventilating engineers, as suggested at

the temporary meeting held this date at the office of 'Heating and Ventilation,' 145-146 World Building, New York City."

Fred P. Smith,	Jas. A. Harding,
Albert A. Cary	Morris S. King,
Albert A. Cryer,	Wm. A. Russell,
O. L. Breckenridge,	W. M. Mackay,
Edward A. Munro,	Thos. Barwick,
Percival H. Seward,	L. H. Hart,
Hugh J. Barron,	W. B. Wilkinson,
Geo. B Cobb,	H. M. Swetland.

At this same meeting a committee of five was appointed to formulate plans for organizing a society of heating and ventilating engineers. The five men selected were:

Mr. Fred P. Smith, Mr. Jas. A. Harding,
Mr. Hugh J. Barron, Mr. Wm. M. Mackay,
Mr. A. A. Cary.

That this Committee on Organization entered into their work with enthusiasm is shown by the record of their meetings. The first general meeting of the Committee of Sixteen referred to was held on August 2, 1894. The Sub-Committee on Organization met in Mr. Barron's office on August 6th, 13th and 20th, and at the meeting of August 20th they selected September 10th as the date for the first general meeting of those invited to join the proposed society, and fixed on the Broadway Central Hotel as the place for meeting. The Committee met again on August 27th and completed arrangements for this general meeting.

A sub-committee, Messrs. Harding, Swetland and Barron, was appointed to select a list of names of heating and ventilating engineers to whom invitations to become charter members should be sent. This committee sent invitations to 157 men, inviting them to become charter members. Of those invited, 75 accepted and became charter members before the date fixed for the closing of the list of charter members.

In order also to be fully prepared for the general meeting of September 10th, a form of proposed Constitution and By-Laws was prepared, to be submitted to the general meeting.

The preliminary arrangements being completed the General Committee and the Sub-Committees looked forward with special interest to September 10th, when the general meeting would show the result of their efforts.

Who of us who were present at the formal birth of the Society at the Broadway Central Hotel on September 10, 1894, do not remember it! My strongest recollection is that it was about the hottest day I ever spent in any meeting. There was no necessity for a system of humidistats; those present furnished all the moisture necessary; but the heat did not keep down the enthusiasm or check the interest in the proceedings.

Those present had come from widely separated sections with the idea of starting a society that would bring the business of heating and ventilating to a higher standard and place it on a plane with other branches of engineering.

The meeting was called to order by Mr. Fred P. Smith, who made an address in which he stated clearly the object the Committee of Sixteen had in view in organizing such a society. After Mr. Smith's address, Mr. L. H. Hart, the temporary clerk, read a list of those who had forwarded their signatures as Charter Members of the proposed society. This list was composed of seventy-five names; forty of these seventy-five remain with us to-day; two, Mr. L. H. Hart and Mr. Wm. McMannis, have joined the great majority, and thirty-three have ceased to be members for various reasons.

The first serious business undertaken at this general meeting of September 10, 1894, was the adoption of a Constitution and By-Laws. The Committee on Constitution and By-Laws suggested "The Society of Heating and Ventilating Engineers" as a title for the new Society. The debate that followed this suggestion was a spirited one. One member objected to the proposed name and wanted a more definite title, while another thought the name was all right; that other societies might be founded, but they would not count for much, and that the word "THE" in large letters expressed his idea of what the Society was bound to become. Still another member, our Secretary, Mr. Mackay, suggested that the Society be called "The International Society of Heating and Ventilating Engineers," inasmuch as foreign engineers had been invited to become members. Mr. Mackay's idea seemed to be to take

in the entire world and prevent infringements, on the general idea expressed by the first member, that we were "The" Society, with a capital T.

After a long discussion the perspiring members reached the conclusion that the heating and ventilating engineering required in America would be a sufficient tax on the Society for some years to come, and when Mr. Harding moved, and Mr. Barron seconded, the motion that the Society be called "The American Society of Heating and Ventilating Engineers," the motion prevailed.

After this important decision the members settled down to a businesslike discussion of the various articles of the proposed Constitution and By-Laws, and before the meeting adjourned had adopted the Constitution and By-Laws proposed by the Committee, with a number of modifications; not, however, without many debates, which were sometimes very spirited, but characterized always by good feeling.

As this original meeting was called merely for the purpose of organization, nothing outside of business questions was given consideration. It was decided to call the first annual meeting in January, 1895, at which meeting papers on heating and ventilating matters should be read and subjects discussed, and the real work for which the Society was organized begun. After electing officers the meeting adjourned, every one present feeling that a good foundation had been laid and that with honest effort on the part of every member the Society was bound to succeed and to result in much good.

The Officers, Board of Managers and Council held a number of meetings between the organization meeting of September 10th and the date fixed for the first annual meeting, January 22, 23 and 24, 1895. The result of this preliminary work was shown at this first regular meeting, which was held in the hall of the American Society of Mechanical Engineers, 12 West Thirty-first Street, New York.

At this meeting eight original papers were presented by members on subjects which were most interesting and brought out a very general discussion on the part of those present. I quote the list of subjects as evidence that the newly born Society's aim was a high one:

"Determining the Heating Power of Heating Systems," Professor J. K. Kinealy.

" Heating and Ventilation of School Buildings," T. J. Waters.

" Testing of Steam Radiators," Professor R. C. Carpenter.

" A Short Talk on the Construction of Hot Water Radiators," J. J. Wilson.

" A Prison Heating and Ventilating Plant," H. B. Prather.

" The Literature of Heating and Ventilation," H. J. Barron.

" The Heating and Ventilating Engineer; a Commercial View," S. A. Jellett.

" Heating and Drying by Exhaust Steam," A. A. Hunting.

This first regular meeting brought out clearly the aim of the founders of the Society; that it was to be a society for real work and honest work; that the second article in our Charter meant what it said when it stated the object for which we asked to be incorporated, viz.: " For the promotion of the arts and sciences connected with heating and ventilation, the improvement in the mechanical construction of the various apparatus used for heating and ventilation, the reading, discussion and publication of professional papers, and the interchange of knowledge and experience among its members." The American Society of Heating and Ventilating Engineers stands for honest work. It aims to establish honest standards by which work may be judged, which standards, because of their honesty, correctness and fairness, shall be the accepted standards in our branch of engineering.

It was high time that such a society should be started. Between the so-called " Heating and Ventilating Engineer," who did not understand his business, and the heating and ventilating engineer who was 75 per cent. fakir, the public was getting but a poor return for its money. There was a general ignorance on the subject of heating and ventilation, and there were any number of contractors who had patented schemes, designed to give all the heat desired at practically no expense for fuel; in fact, after reading some of the descriptive matter, one felt that a coal bin had ceased to be a necessary adjunct to any building. The results of the efforts of contractors and engineers of this class was that the installation of steam and hot water heating apparatus was so generally unsatisfactory that the outlook for business was not favorable, and one of the principal aims of this Society has been to set up standards which will be the

measure for good work, after these standards have been sufficiently tested to prove their worth.

John Ruskin says: "I hardly know anything more strange than that you recognize honesty in play, and you do not in work. In your lightest games, you have always some one to see what is called 'fair play.' In boxing you must hit fair; in racing, start fair. Your English watchword is fair play, your English hatred, foul play. Did it ever strike you that you wanted another watchword also, fair work, and another hatred also, foul work? Your prize fighter has some honor in him yet; and so have the men in the ring around him; they will judge him to lose the match by foul hitting. But your prize merchant gains his match by foul selling, and no one cries out against that. You drive a gambler out of his gambling-room who loads dice, but you leave a tradesman in flourishing business who loads scales! For observe, all dishonest dealing is loading scales. What does it matter whether I get short weight, adulterate substance, or dishonest fabric? The fault in the fabric is incomparably the worst of the two. Give me short measure of food, and I only lose by you; but give me adulterate food, and I die by you."

The value of the work done by the Society since its organization can be better understood after a perusal of the Yearly Proceedings. Eighty-one original papers are published in the nine volumes, seventy-six of which were contributed by our own members. I do not propose to discuss these papers in this article, but wish to call your particular attention to the fact that many of them give to heating and ventilating engineers information on branches of the business which were but little understood. For example, most heating contractors, eight to ten years back, based their calculations for the installing of hot blast systems of heating on the data in the catalogues of the manufacturers of fans and blowers, and after they completed the erection of a hot blast system of heating based on data thus obtained, if they were paid in full for their work, Providence was kind to them. This Society has contributed very largely to the sum of knowledge on this branch of heating and ventilating work, as witness the following list:

"Forced Blast Warming with Furnaces," Geo. W. Kramer.

"Determining the Velocity of Air Passing through a Register per Minute," Professor J. H. Kinealy.

" Relative Efficiency of Ventilation by a Chimney and by a Fan," Professor R. C. Carpenter.

" A New Type of Hot Blast Radiator," Geo. I. Rockwood.

" Heating and Ventilating Church and Parish Buildings by Forced Draft," B. Harold Carpenter.

" Some Experiments with Centrifugal Fans," W. S. Monroe.

" Some Formulas for Disk Fans," Professor J. H. Kinealy.

" The Calculation of Centrifugal Fans for Ventilating Purposes," H. Eisert.

" Investigations of a Blowing Fan," Professor R. C. Carpenter.

" Theory of the Centrifugal Fan or Blower," Professor R. C. Carpenter.

" Methods of Testing Blowing Fans," Professor R. C. Carpenter.

" The Calculation of Disk Fans," H. Eisert.

" The Condensation of Steam in Blower Systems of Heating," Professor R. C. Carpenter.

" The Performance of Centrifugal Fans under Actual Working Conditions," H. Eisert.

" A Test of a Fan Blower with Cast Iron Radiating Surface," Professor R. C. Carpenter.

In addition to the above seventeen papers the following articles describing heating systems give additional data on hot blast warming:

" Heating and Ventilation of School Buildings," T. J. Waters.

" A Prison Heating and Ventilating Plant," H. B. Prather.

" Heating and Ventilating of Large Churches," H. B. Prather.

" A Test of the Heating and Ventilating Plant, New York State Veterinary College, Cornell University," Professor R. C. Carpenter.

" English Practice in the Warming and Ventilation of Technical and Art Schools" D. M. Nesbit.

In all, twenty-two papers, which throw light on all branches of blower and hot blast work, and to these should be added the additional facts and general information brought out by the discussions following the reading of the papers, which appear in the Proceedings.

It is interesting to note that the first paper read at the first Annual Meeting was on the very important question of "Determining the Heating Power of Heating Systems," and the first topic discussed was "Whether, in designing a system of heating and ventilation, we shall heat by radiation and supply only tempered air for ventilation, or shall we heat by the air supplied for ventilation?" This was certainly a good beginning, as the heating and ventilating engineer in 1894 was badly in need of information on both subjects.

The Society which began with seventy-five Charter members has to-day 204 members in the various classes, but the records show that since organization we have admitted 312 members. It is but natural that a number of men should come into an organization of this kind for commercial reasons, and among those who signed as Charter members and those admitted during the first few years were a number of men whose connection with the sale of heating and ventilating apparatus led them to believe that membership in the Society would assist them in the sale of their apparatus. It did not take any very great length of time to disabuse their minds of this idea and to clearly impress upon them the fact that the commercial side of the business of heating and ventilation was to be left to the Master Steam Fitters' Association. This fact accounts for the disappearance during the first three or four years of a large number of names from the list of members.

But five members have died since the organization. They are:

L. H. Hart, Editor of "Heating and Ventilation," and one of the original three organizers, and very active in building up the Society, who died January 26, 1897.

Jas. W. Gifford, who died July 26, 1899.

Wm. McMannis, Chief Engineer Public Schools, New York City, who held important offices in the Society, and who died January 19, 1901.

Chas. F. Tay, who died September 8, 1901.

Arthur H. Fowler, inventor and first manufacturer of the wall radiator, who died June 3, 1903.

The Proceedings of the Society are distributed to 39 colleges, engineering schools and engineering clubs, following the idea that the Society has always held that the widest possible

distribution of a knowledge of the Society's work not only results to the general good of the public, but also reacts to the good of the Society itself.

In addition to the regular Annual Meetings, the Society has held six semi-annual meetings, as follows:

New York	June 18, 1897.
Atlantic City	July 15, 1898.
Saratoga	July 21 and 22, 1899.
Chicago	July 12 and 13, 1901.
Atlantic City	June 16, 1902.
Niagara Falls	July 17 and 18, 1903.

At these semi-annual meetings papers were read and topics discussed which are included in the annual proceedings. It is not my intention to go into statistics as to the number of topics discussed, how many members took part in the discussion, the number of volumes of each year's Proceedings published and other similar details, as I am somewhat of the opinion of a celebrated lawyer who said to the jury, after cross-examining a statistical witness, that there were three kinds of lies, "Lies, D—— lies, and statistics." Suffice it to say that the published Proceedings of the Society contain a summary of all that was read and said at the meetings that is worth preserving.

The Society has also done a vast amount of work during the ten years of its existence in the interest of having laws passed in the various States making it compulsory that school buildings, hospitals, and other buildings where a number of people are gathered, shall be properly ventilated. While the Society has not been successful in having any bills passed as yet, we have succeeded in creating considerable interest in the matter, and I believe the educational work done in this direction will bear satisfactory results.

At the fifth Annual Meeting of the Society held in January, 1899, a paper was presented on "The Relation between the Heating Engineer and the Architect." As a result of the discussion which followed the reading of the paper a committee was appointed to bring to the attention of the American Institute of Architects the matter of professional charges for engineering services in preparing plans and specifications for

heating and ventilating work. This Committee succeeded in having a committee appointed from the Institute of Architects to meet them, and after some two years' work which included some setbacks, the joint committee had the satisfaction of having their recommendations, in an amended form, accepted by the Institute at its meeting held in Buffalo, N. Y., November 4, 1901. The clause as adopted is now incorporated in the Schedule of Charges of the Institute.

From the first annual meeting of the society there has been a Committee on Uniform Contract and General Conditions Governing Specifications. This Committee has worked through nine years, and you have before you the result. The conditions varied so greatly in different sections of the country that the work of framing a contract that would meet the conditions and be fair to both parties in interest presented great difficulties. One of our members who had done good service on the Committee said, after working for some months, "It seems like attempting the impossible." Yet I believe that the Contract and General Conditions Governing Specifications, as adopted, are a great improvement on anything of the kind yet done and will meet the conditions of the heating trade in a majority of cases and will materially add to the Society's prestige when brought into general use.

The work begun in 1894, and continued with ever increasing vigor since, has made clear to all interested in the subject of heating and ventilation that The American Society of Heating and Ventilating Engineers to-day is not an impracticable or visionary undertaking, but an assured success. We realize, however, the fact that

> Heaven is not reached at a single bound,
> But we build the ladder by which we rise
> From the lowly earth to the vaulted skies,
> And we mount to its summit, round by round.
>
> —J. G. HOLLAND.

The work is well begun, but only begun. The Society needs the best efforts of all its members, and it extends an invitation and offers an opportunity to all Heating and Ventilating Engineers to join its membership. The future opens before us wider and wider with all its possibilities, but to enter in and possess it, our work must be founded on earnest, honest effort.

To achieve success we must realize that " to whatever degree we appreciate ourselves and our powers, putting forth laudable efforts to maintain and develop them, just to that extent will the world accord to us place and power and distinction, and so measured must our success be."

CXXI.

A REVIEW OF SOME HEATING LITERATURE.

BY H. J. BARRON

(Member of the Society.)

From the earliest times criticism has been a thankless task, and one which the man of tact makes it his practice to avoid; and while I do not aim in this article to do any "knocking," certainly none with any malice, I think I may be undertaking something which my more tactful brethren might shrink from.

In the following notes on various papers read before the earlier conventions of the National Association of Master Steam and Hot Water Fitters, and the discussions which took place upon those papers, I hope to be of some service in resurrecting buried documents and getting the thoughts of the authors of the papers put in shape for a more permanent record for those who come after us. We are all working for others, and everything that we have is due to the work of our predecessors and our contemporaries.

At the Master Fitters' Convention, held at Philadelphia in 1891, I and many others objected to the further reading of papers. Mr. Harry D. Crane, formerly president of that association and now president of our Society, vigorously opposed my position, urging that the thoughts of earnest men in regard to their life work should be sought for and their expression and publication encouraged. I think that to his arguments in the course of that discussion it is largely due that the theories and methods of present-day heating engineers have been so fully recorded.

At the preceding convention, held in New York in 1890, Mr. J. H. Mills, of Boston, read a paper, which was discussed by the late Mr. Chas. J. Gillis and some others, and which created some ill feeling in the secret souls of others who failed to put themselves publicly on record.

In 1892 the Convention was held in Boston. The first paper read was one by Mr. Arthur C. Walworth, on "Old Times in Steam Heating." The author ably covered the introduction into this country of wrought iron pipe and everything that goes with it, including steam-fitting. He gave the names of the early workmen, but the paper was purely Bostonian and almost entirely ignored the work of Nason in New York, and the contemporaneous work of Morris & Tasker in Philadelphia. This paper was discussed by Mr. Kendricken, also in a purely Bostonian local spirit—I should say a "hub" spirit, as the spokes and the tire had nothing to say just then.

Following this, Mr. Gillis read a paper on "Architecture and the Architect." His remarks in this paper on the judicial position of the architect, as between the client and the contractor, are true for all time. Mr. Gillis was a fine example of the courteous, conscientious, nineteenth-century gentleman. He was a classmate of General Grant at West Point, and the army lost an able officer when he left it for the steam-heating business.

The next paper before this convention was by Mr. E. P. Bates, of Syracuse, on "Utilization of Exhaust Steam," in which he described the plant he had put in for Studebaker Bros., at South Bend, Ind. This paper is one of the most valuable ever published on exhaust heating. There was some discussion on this paper, and I recall that Mr. Bates advocated enlarging the exhaust ports of engines to facilitate the exit of the exhaust to the system. As Mr. Bates was an old marine engineer, this rather shocked me, but it is possible that he merely meant the outlets from the ports, as no engineer would let a steam fitter alter his valve ports.

The next paper was by Mr. H. D. Crane, of Cincinnati, on the "Vacuum System of Steam Heating." Mr. Crane confined himself largely to the Barnard system, giving proportions for risers, etc., and describing its use in connection with the overhead supply, single pipe system. This was a thoroughly practical paper and describes, for exhaust factory heating, a system identical with the so-called vapor, or French, or Tudor systems. The method of withdrawing the air and producing the partial vacuum, and the means of sealing the risers and regulating the volume of valves to prevent short circuiting, is in principle the same. My own opinion is that the sizes given for risers, etc., could be reduced one-half.

The next paper was entitled "Variations in Practice," by H. J. Barron—no connection, or very little, with the present writer. Marcus Aurelius says that "nothing is; everything is becoming." It was intended to provoke discussion, but it did not, although Mr. Franklin and Mr. Bates discussed Mr. Crane's paper.

The next paper at that convention was by Mr. Breckenridge, of Boston, entitled "Steam Heating Below Atmospheric Pressure," and was an exposition of Mr. A. G. Paul's system; a well written and concise paper, but there was no time for proper discussion.

At the 1893 convention held in Chicago, the most valuable ocument presented was probably Mr. Bates's report of the Committee on Standard Flanges—merely a committee report.

The first essay was Mr. A. C. Walworth's presentation of a continuation of his previous paper, "Early Days of Steam Heating," but written by his father, Mr. J. J. Walworth. Here we have the story of the early days of an art elaborated by the chief actor, and I think this paper, for that reason, a very valuable contribution.

The next paper was by the present writer, entitled "A Look Ahead." Its main purpose was to shake up the spokes and the tires, but it did not look far enough ahead, as the shaking up was more effectively done in the last paper read at the convention, to which I will refer later.

The next paper was by Mr. L. H. Prentice, on "Brotherly Love"; an excellent essay on the spirit of fraternity among those engaged in the same art.

Then Mr. Geo. D. Hoffman, of Chicago, read a paper on "Combination Heating," which was largely a defence of the hot-air furnace. It was an excellent paper and evoked some discussion of the sneering kind indulged in by many steam fitters when discussing furnace work.

The next paper was "Wasted Heat," by Mr. H. W. Heath; a very good paper on utilizing the waste products of combustion.

The next was by Mr. A. B. Franklin, of Boston, on the "Paul System," a continuation of Mr. Breckinridge's paper of the previous year. This paper gives the results of a number of practical tests, but there was no time for discussion.

The next, and probably the best paper of the World's Fair meeting was that by Mr. R. T. Crane, of Chicago, on the "Early History of Wrought Iron Pipe." Then the spokes and the tire did some historical correcting for the hub. The paper gave a concise description of the process of making pipe and the early evolution of the industry in England, and Mr. Crane will be remembered by it when his great fortune and his aggressive personality are both forgotten. It was a pleasure to listen to this veteran heating engineer as he delivered this paper, himself a splendid example of the American worker, not forgetful of the calling by which he had advanced himself, nor of the work of his predecessors in England.

At the New York Convention of 1894, Mr. David M. Nesbit, of London, read his paper on "English Practice in Heating and Ventilating"; an excellent exposition of English methods.

The next paper was by Mr. E. P. Bates, on "Difference in Amount of Radiation required in Buildings of Poor and Good Construction," a thoroughly practical paper.

The paper which followed was by Mr. A. C. Walworth on "Types of Heating Boilers in the United States," and was one of the most comprehensive essays ever produced on house-heating boilers, a careful and painstaking compilation of everything that had been done in the boiler line.

Next, Mr. A. B. Franklin read a paper on the "Value of the Exhaust."

This was followed by "Early Reminiscences of Hot-Water Heating," by John B. Farnsworth. This is really a humorous paper, if you consider that the author had started in the year 1890 to see if he could learn something of the methods of hot-water heating, and, as it was the last paper read at this convention, I think it shows the importance of making records of work accomplished, and the importance of accuracy in the history of our art.

The history, written in the blood of the workers, is as truly the nation's history as that which is written in its battles, and, as civilization advances, the history of even an obscure art will be of the greatest importance, and Watt, Howe and McCormick will be remembered when the mighty kings of their day are utterly forgotten.

All the various papers and discussions referred to can be

found in the 1892 and 1893 souvenirs published by the Master Fitters' Association, and in the columns of "Heating and Ventilation." I have thought it appropriate that at our tenth anniversary, the work done in the Master Fitters' meetings previous to the organization of this Society should be resurrected and to an extent merged with the work of this Society, where it properly belongs, to perfect and complete its records and prevent the loss of most valuable material.

I have alluded to the presence of Mr. D. M. Nesbit at the 1894 Convention and of his reading a paper there. After that Mr. Nesbit found it worth while to visit this country very frequently and became a member of this Society. Possibly as a result of Mr. Nesbit's visits and of his observation of the works of this Society, they have in Great Britain to-day the British Institute of Heating and Ventilating Engineers, which was organized in October, 1898, with Mr. Walter Jones acting as president. The first general meeting was held in January, 1899, when Mr. Walter Jones of Stourbridge was elected president. The first toast was to "The Heating and Ventilating Institution of Great Britain and the parent Institution in the United States," and was responded to by Mr. Nesbit.

Their April meeting was principally occupied by the presidential address and a discussion of it. At their July meeting Mr. A. E. Grindrod read a paper of the disfavor shown by fire insurance companies to high-pressure heating apparatus. At their October meeting Mr. W. R. Maguire, of Dublin, read a general paper on heating, and Mr. John Ritchen, of Derby, one on "Heating Surface; its best form and its relation to radiating surface."

At their annual meeting in January, 1900, Mr. D. M. Nesbit was elected president. Mr. Samuel Naylor read a paper on "Boilers for Low-Pressure Hot-Water Heating," and Mr. Nesbit one on "Steam Heating at or below Atmospheric Pressure."

In May Mr. Nesbit freely gave, for the benefit of the members, his own personal experience on radiators, boilers, piping, the execution of contracts, etc. Mr. Nesbit made an address which was discussed at length, together with the paper read by him at the previous meeting too late for discussion at that time.

At the July meeting Mr. R. E. Atkinson read a paper on

"Domestic Hot-Water Supply," and Mr. J. Nelson Russell read a paper on "Low-Pressure Hot-Water Heating."

At their October meeting Mr. R. E. Atkinson read an excellent paper on "Standardization of Flanges," and Mr. Thos. Patterson one on "Range Boilers."

At their annual meeting held in February, 1901, Mr. W. J. Millington read a paper on "Steam as an Agent for Heating Schools, Churches and other Large Buildings." Mr. L. F. Pierson read a paper by Mr. Greenall on the "Plumbers' Legislation Bill."

The principal feature of the July meeting was the paper by President Maguire, largely devoted to the work of the Institution and to the American Society. A paper was also read by John S. Palmer on the "Plumbers' Legislation Bill," which he compared with the Illinois State Plumbing Law.

At the October meeting, Mr. C. Mason read a paper on low-pressure hot-water heating with special reference to dwelling-houses, in the discussion of which much reference was made to American practice, and Mr. Milan a paper on "Domestic Hot-Water Supply and Explosions in Kitchen Boilers."

At the meeting of January 28, 1902, Mr. Walter Yates read an excellent paper on "Mechanical Ventilation," the discussion of which occupied most of the time of the meeting. As an illustration, he used the Antrim County Asylum. At this meeting, Mr. J. Nelson Russell was elected president.

In April, there were papers by E. W. Naylor on "Ventilation of Buildings," by Mr. Charles Pullman on "Warming and Ventilating as available for Public Buildings," and a further paper by Mr. R. E. Atkinson on "The Standardization of Flanges and Fittings," in regard to which it was planned to form a committee consisting of members of the Institution of Heating and Ventilating, Mechanical, Civil and Marine Engineers to formulate a standard.

At this meeting the papers were "Low-Pressure Steam Heating with Open Air Pipes," by Samuel Naylor, and "Boilers Old and New," by Louis F. Pierson.

In January, 1903, Mr. Louis F. Pierson, the new president, presided and read a short but suggestive address. Mr. R. L. Claypool read a paper on "Steam and its Applications to the Heating of Railway Carriages."

The papers read at later meetings are not available, but enough has been said to show that our friends across the water are following our footsteps, and they have a very strong and enthusiastic body of intelligent workers.

CXXII.

DESCRIPTION OF HOT WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION, COPENHAGEN, DENMARK.

By Capt. A. B. Reck.
(Member of the Society.)

I believe that I am not much in error in supposing that the most you have heard about Denmark, gentlemen, is that cows are almost as numerous there as the human beings of the country, and that said cows are well assisted by said human beings in every year converting many shiploads of American corn and oil-cakes into Danish butter, to be eaten by your kinsmen in England.

Therefore, before describing an example of heating, as performed in a Danish building, and especially because I think the method employed is new to you, it perhaps may not be out of place to begin by saying a few words about the climate and other conditions that affect methods of central heating in Denmark.

First, as to temperature, it will be sufficient to say that it is customary with us to provide heating surface in the rooms sufficient to give an inside temperature of 68 degrees F. for an outside temperature of 4 degrees below zero. As you will see, this makes a difference of 72 degrees F. between outside and inside, or only a very little more than the 70 degrees F. which I understand it is customary to provide for in most parts of the United States.

I have to explain to what extent the outside temperature is variable during winter. You know that Denmark is situated just between the North Sea and Sweden. The result of this situation of the country is that the climate in most winters is extremely unsteady. After a period with mild western winds, there can suddenly follow from the North Sea a considerable

drop in temperature, if the wind swings East and comes from Sweden. Consequently our heating apparatus must be capable of dealing with very sudden and considerable drops in temperature.

Next, as to winds; the fact is that often in winter strong winds are blowing for weeks over Denmark. I think you will really find fewer people wearing high hats in Copenhagen than in any other European capital.

From all this I think you will see, gentlemen, that the task of the heating engineer is not easier in Denmark than anywhere else. Perhaps it is even a little more difficult. Only, in one respect, the Danish engineers have nothing to complain of; if they have a really good thing to propose, a thing that is advantageous from either an economical or a sanitary point of view, they do not find the people of their country slow to adopt it. That applies to other branches of engineering just as well as to heating and ventilating.

For instance; I dare say that few cities have better water and better sewers than the city of Copenhagen. No sewage is allowed to go into the harbor, but all is pumped out into deep water with a strong current, far away from the town.

As to heating, we have in Denmark gone through the whole series of systems, from stoves to hot air furnaces, from these to steam heating, and from steam to hot water.

The objections to steam heating that have produced the last named change are mainly:

Deficiency in regulation of temperature in rooms, and too much heat in all ordinary weather; therefore, too much coal consumption.

Difficulty in keeping the apparatus in order, especially if the steam system employed includes the use of many steam traps or automatic air valves.

Last, but not least, the cost of repair work, especially on the returns. These very often have to be replaced after twelve to fifteen years' use.

I shall now give you a brief description of the heating installation my company has done in the Schiodann Institution in Copenhagen, this installation being a fair example of about two hundred similar installations made by my company and its European licensees in the last few years.

The system employed is a low pressure hot water system, the water circulating in the apparatus by the influence of difference in specific gravity between the ascending and descending columns of water. The special feature of this system is that all heat is transferred to the water by low pressure steam and that whenever the pressure of the steam is raised a few pounds over that ordinarily kept, the water will be heated to the boiling point in the flow mains without danger of the water boiling over from the expansion tank and at the same time the velocity of the water will be accelerated to about four times as much as what is attained in an ordinary low pressure hot water apparatus.

The possibility of elevating the temperature of the water in the flow mains of a low pressure hot water apparatus to boiling point gives a considerable saving in heating surface without danger of overboiling and, at the same time, the great augmentation in the velocity of the water permits going much further from the boiler with the mains, and using only about one-fourth the sectional area in all mains and risers, as compared with the ordinary low pressure hot water apparatus. How this is attained will be best understood by looking at the accompanying explanatory sketch of the system, Fig. 1.

Steam is here shown taken from a low pressure steam boiler, A. The type of boiler shown is that used in the Schioldann Institution, but any type of boiler can be used, and even the exhaust from a steam engine is as good a source of steam as a low pressure steam boiler. The steam is first taken into a reheater, B, where it heats through metallic surfaces the water of the hot water apparatus coming from the return water main, R, and passing through the reheater to the main rising hot water pipe, S. The metallic surfaces in the reheater, B, are generally made large enough to heat the water in S to a temperature of 185 degrees F., but the admission of steam to the reheater, B, can ge regulated automatically, or by hand, to give any lower temperature desired in the rising pipe, S. This pipe, S, ends in the expansion tank, E, but before it enters here, there are inserted in it two special apparatuses required by the system: the condenser, F, and the circulator, C, to be described later. These two apparatuses, however, do not impede the flow of the water from the reheater, B, to the expansion

tank, E, so if the expansion tank and the reheater are connected by any ordinary system of hot water mains, pipes and radiators, in which the water is giving off heat to the building, you will see that it will be possible to work such a hot water apparatus at all temperatures below 185 degrees F., the reheater, B, replacing the ordinary hot water boiler in every respect.

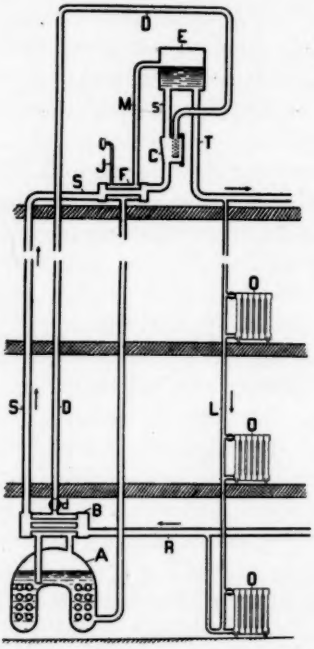


FIG. I.—HOT WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION.

In the sketch, the flow main, T, of the hot water apparatus is shown placed in the attic of the building, and the radiators, O, are shown connected to the risers on the one pipe plan. This is shown so only because said one pipe system is used in the special building we have before us, but in other buildings we have used the two pipe system, and we have taken the flow main, T, down into the basement before it passes out through the building.

I will now describe the special apparatus which makes it possible to heat the water to boiling point, and at the same time to accelerate its motion.

From the steam space of the reheater, B, a steam pipe, D, rises to the attic, where in the circulator, C, it ends in a noiseless mixing apparatus for mixing the steam with hot water passing through the main rising pipe, S. As the circulator is always placed a certain distance below the water level in the expansion tank, E, it follows that no steam will go into the circulator as long as a pressure regulator, regulating the steam pressure in the reheater, B, prevents this pressure from exceeding the water pressure in the circulator, C. Thus you will see that a simple change of the location of the weight on the lever of the steam pressure regulator in the basement gives the attendant means for almost instantly putting the circulator in or out of action, as circumstances may require.

Now if the steam in the reheater is allowed to have sufficient pressure for penetrating into the circulator, C, and mixing itself with the hot water here, the result will be that this water, in passing further up through that part of the main pipe, S, which connects the circulator with the expansion tank, will have a very strong admixture of steam bubbles, making the specific gravity of this part of the water column in the rising pipe less than half the specific gravity of a column of water at boiling point without admixture of steam.

The acceleration of the water in the hot water apparatus, as soon as steam penetrates into the circulator, is due to this great diminution in specific gravity of the uppermost part of the column of rising water. When the water reaches the expansion tank, the steam contained in the bubbles will be discharged from the surface of the water, so that already when descending through the first part of the hot water main, T, the water will be once more perfectly free from steam. The steam discharged from the surface of the water in the expansion tank will reach the condenser, F, through the overflow pipe, M, where it will be condensed and returned thence to the boiler, A, through a special return pipe from the steam space of the condenser.

The condenser, F, consists of a steam jacket or series of tubes inserted on the main rising pipe, S. Its condensing surface must be sufficient to condense the steam discharged from the expansion tank, the volume of this steam always being in a certain proportion to the weight of water passing through the hot water apparatus.

To give an outlet for what air is contained in the upper part of the expansion tank, in the overflow pipe and in the condenser, before steam penetrates the circulator, in ordinary apparatus such as that installed in the Schioldann Institution in Copenhagen, an ordinary automatic air valve is fixed on the condenser, F. If, however, exhaust steam, instead of a low pressure steam boiler, is employed for the heating, and if it is desired to relieve the engine of all back pressure, no such automatic air valve is used on the condenser, F, but from this a pipe is run to a pump in the basement, and a valve on this pipe is controlled by a special regulator in such a manner that no more vapor will pass the pipe to the pump than necessary to keep a sufficient vacuum in the condenser and over the water in the expansion tank. The regulator is acted upon by the very suction produced by the circulator, so that it only keeps the valve open when the suction is less than desired. You can find a description of this regulator in a paper read at the October meeting of the British Institution of Heating and Ventilating Engineers by my English licensee, Mr. C. I. Haden, and published in the " Engineering Review " in December last.

In all cases the attendant can raise the temperature of the water and send it through all the pipes and radiators with greatly augmented velocity by moving the weight on the main steam pressure regulator in the basement. In practice this is done almost every morning, all the year round, and thus a suitable temperature is created in the rooms in a very short time. This time is so much shorter than by ordinary low pressure hot water heating, because the mains and pipes as formerly mentioned only need about one-fourth the sectional areas, so it takes very little heat to get their contents of water up to the desired temperature. As soon as the building is well heated, the attendant lets the steam pressure drop sufficiently to put the circulator attachment out of action, and runs the apparatus the remainder of the day as an ordinary hot water apparatus and at such a temperature of the water as is best suited to the outside temperature. Any one familiar with practical heating knows how much the heating capacity of radiators may be diminished when once the desired temperature is attained in the rooms. I have myself for a long time occupied an office heated by low pressure steam, where I had divided the radiator into

three parts, one part 60 per cent., one 25 per cent., and the last part 15 per cent., each part with its own valve. At any time, when the difference in temperature between outside and inside was not over half of the maximum difference the heating apparatus was calculated to provide for, it was sufficient to use only the 15 per cent. portion of the radiation as soon as the temperature of the room had been raised to what was required.

The quick and effective central regulation that can be attained by the system described makes it quite unnecessary to divide the radiation in a room into several parts, as has often been found necessary if automatic regulation of temperature in the rooms by thermostats shall be really effective. Such a system of automatic regulation is so desirable that I think any means that tends to diminish its cost, and thus make it easier to get it adopted, will be favorably looked upon.

Before I refer to the plans and sections of the building of the Schioldann Institution accompanying this paper, it will be necessary to explain what is meant by the letter " N " put before all the statements of heating surface carried by the mains and risers.

In a paper read before this Society in January, 1900, Mr. James Mackay said about water heaters:

" It would seem quite possible for manufacturers of heating boilers to adopt as standards a certain pressure for steam boilers and a given temperature for water boilers."

I fully endorse these words, and I think that when, for instance, several American manufacturers put a much higher rating of hot water boilers in such of their catalogues as are destined for England than in those destined for America, such discrepancies may be fully justified by the different customs in the two countries, but I think it will be admitted that it would be desirable if they could be wholly avoided by the adoption of a standard.

It is really the same thing with hot water mains and risers as with boilers. You will find in all handbooks rules for determining the sizes of such mains and risers according to the heating surface they have to carry, but as long as no standard is adopted, as to how much heat can be expected to be given off from the heating surface, the value of the rules is very lim-

ited, as the number of square feet the same main or riser will carry, of course, is wholly in proportion to how much the water is allowed to cool down in the radiators and, therefore, to the heat emitted from them.

If it was customary in America and England to use the British Thermal Unit in calculations of heating apparatus and ratings of boilers, no need of a standard in hot water heating surface would exist. Now, it is well known that such is not the case. The B. T. U. is so small that very high numbers (very often several millions) would have to be used for boilers and mains, and it would be difficult for many able men in the craft to be as familiar with those high numbers as they are now with the numbers of square feet of heating surface. It is to be remembered here that in low pressure steam heating, where the temperature of the heating surface is always very nearly 212 degrees F., there can be no objection to the rating of boilers, mains and risers according to the heating surface, so it would be convenient if a similarly uniform method of rating could be used in hot water heating.

Now, in the absence of any generally adopted standard of heat emitting hot water surface, and having to give my licensees very definite rules, especially for all mains and risers, I had to choose a standard myself. The standard I have adopted is a square foot of the ordinary pattern of two column cast iron radiator, 38 inches high, heated to a temperature of 160 degrees F., and placed as direct radiation in a room where the temperature is 68 degrees F. I have found that a square foot of heating surface under those circumstances will emit very nearly 160 B. T. U., or about 40 calories in the metric system. I have called this standard a " Nominal " square foot of heating surface, and, accordingly, on plans and diagrams, I always put an " N " before the number of square feet, when I do not mean actual surface.

There is more than one advantage in this standard. First, it is so low that even in England, where, I think, it is customary to use lower temperatures in hot water heating than in America, boiler manufacturers would not need to reduce the surface which they now specify in their catalogues their boilers will carry.

Secondly, there is only one round number to remember, the

temperature of the radiator and the number of B. T. U. emitted being 160 each.

Thirdly, the number of metric calories for the standard being 40, this is a round number also, so that, for instance, it is easy to choose a boiler from a catalogue where the capacities of the boilers are given in calories.

As long as American and English heating engineers have not agreed upon a certain standard of hot water heating surface, some of you might find it convenient in your office work to use the " Nominal " square foot as a standard. For the convenience of those, this paper is accompanied by a diagram (Plate 2) from which you will be able to see, on the vertical left-hand side, the proportion of heating surfaces of different kinds and temperatures to the standard " Nominal " surface. You will find the mean temperatures of the radiators in Fahrenheit degrees along the bottom of the diagram, and you will see that the number " 1 " on the left-hand vertical side corresponds on curve " I " to a mean temperature of 160 degrees.

The horizontal distances between each 10 degrees F. at the bottom of this diagram are in inverse proportion to the heat emitted per square foot by the radiators. For instance, the distance between 130 degrees and 120 degrees is double the distance between 170 and 160 degrees, because betwen 130 and 120 degrees a radiator will only emit half the heat that is emitted between 170 and 160 degrees. I have made the divisions in this new manner on the diagram, because it is thus possible at once to find the real mean temperature and the real heat emitting capacity of a radiator as soon as you know at what temperature the water comes in at the top, and at what temperature it leaves the radiator at the bottom. For instance, if you know that the water in a radiator of the type represented by curve " I " will go into the radiator at a temperature of 170 degrees, and leave it at a temperature of 120 degrees, then, as the number 140 degrees is found about in the middle, between 170 and 120 degrees, the mean temperature of the radiator will be about 140 degrees, and its heat emitting power will be about 0.73 of a " Nominal " square foot, because this number on the left-hand side corresponds to 140 at the bottom. If the horizontal line had been divided into equal distances for each ten degrees, of course you would have found 145 degrees as the

mean between 170 and 120 degrees, but if then you had taken 0.80 of a Nominal square foot (on the left side) as the heat emitting power of the radiator, you would have overrated it. The real mean temperature of a hot water radiator must generally

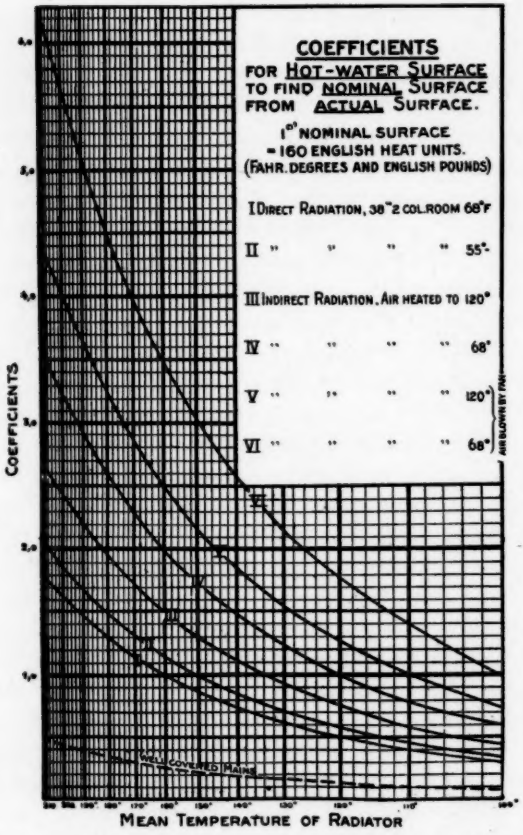

COEFFICIENTS
FOR HOT-WATER SURFACE
TO FIND NOMINAL SURFACE
FROM ACTUAL SURFACE.
1 SQ. FT. NOMINAL SURFACE
= 160 ENGLISH HEAT UNITS.
(FAHR. DEGREES AND ENGLISH POUNDS)
I DIRECT RADIATION, 38" 2 COL. ROOM 68° F
II " " " " 55°
III INDIRECT RADIATION, AIR HEATED TO 120°
IV " " " " 68°
V " " " " 120°
VI " " " " 68°
AIR BLOWN BY FAN
COEFFICIENTS
MEAN TEMPERATURE OF RADIATOR

PLATE 2.—HOT WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION.

be somewhat lower than the arithmetical mean between the temperatures of outflow and inflow, because the water must cool the more rapidly the higher its temperature is. To find the exact mean temperature of such a radiator by calculation is a rather onerous task. By my diagram you will find it a very easy matter.

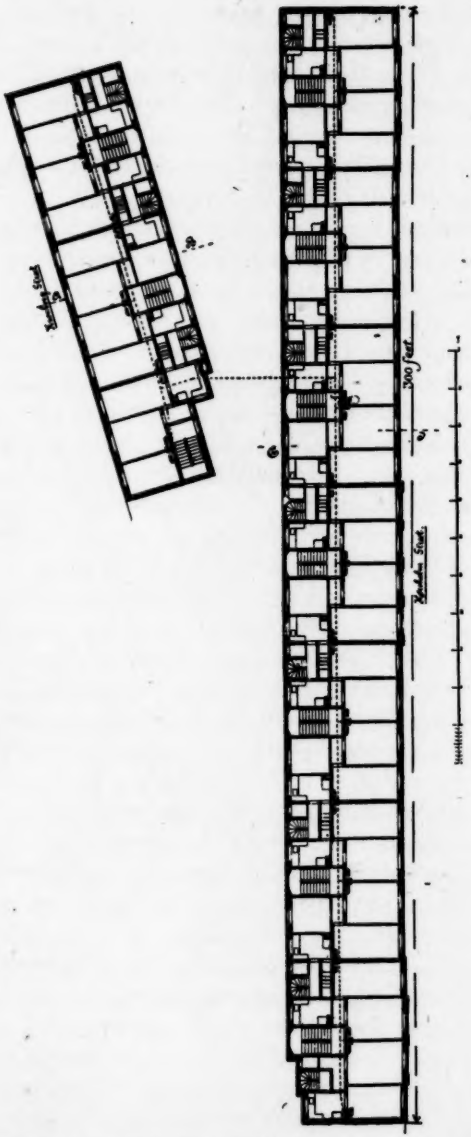


FIG. 3.—HOT WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION.

In the paper read by Mr. James Mackay before the Society in January, 1900, which paper is mentioned above, Mr. Mackay gave a table of the heat emitting capacities of hot water radiators at different temperatures. The curve " I " for direct radiation in my diagram, found partly from tests made by me and partly from calculations, agrees surprisingly well with the table published by Mr. Mackay.

I now ask you, gentlemen, to look at the plans and sections of the Schioldann Institution. From the plans you will see that this institution consists of two buildings, separated by a space from 30 to 50 feet wide. The buildings contain in five floors 100 two-room suites, occupied mostly by aged people, who have secured shelter here for their lifetime. Many of the rooms in the basement are included in the system of central heating. The length of the large building is 300 feet; that of the small building is 115 feet. Both buildings are heated from the same heating chamber, situated in the basement of the large building. In this chamber are placed side by side two low pressure steam boilers, each with 190 square feet of fire surface. In mild weather only one boiler is used. The fuel hoppers of the boilers contain so much coke that the boilers can run eight hours in very cold weather without need of attendance. The steam pressure in the boilers never exceeds five pounds. The cubical contents of the rooms heated from the two boilers are nearly 300,000 feet. Vent flues extract the vitiated air from the rooms. The windows are large and the front of the large building is much exposed to the wind. A temperature of 68 degrees F. can be maintained in the rooms at an outside temperature of 4 degrees below zero F. Radiators, partly sectional cast iron and partly wrought iron pipe coils, are placed in the rooms, with a total heating capacity equal to 6,210 " Nominal " square feet, equal to about one million B. T. U. All the surface is carried by a 3½-inch main pipe rising from the reheater over the boiler to the circulator and the expansion tank in the attic in the large building. From the expansion tank the hot water is distributed by two 2½-inch and one 2-inch horizontal mains in the attics. The main that heats the small building is carried by an iron beam across the open space between the buildings. This main is provided with extra thick covering, and well protected against rain and snow. The radiators are connected

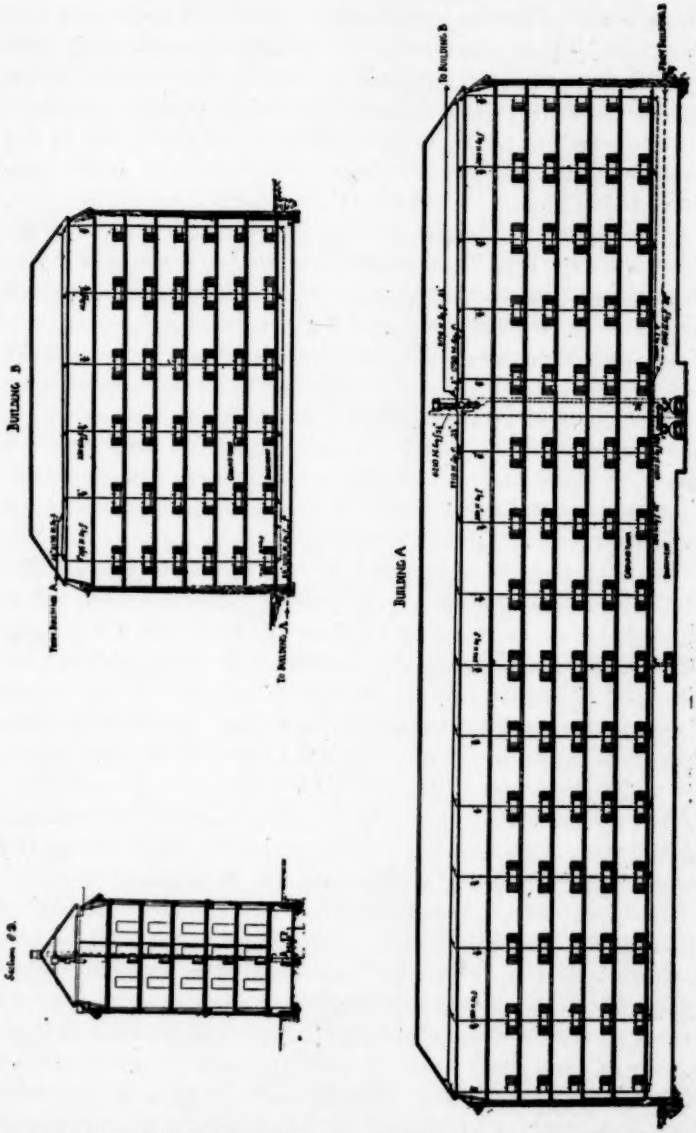
to the risers on the one pipe system. Each riser carries 10 to 12 radiators. Most of the risers are ¾ inch diameter, and carry a little over three hundred "Nominal" square feet (about 50,000 B. T. U.) each. The main return pipes in the large building are placed under the ceiling in the basement; in the small building, in a sub-basement. They have the same diameters as the main flow pipes.

The apparatus operates in such a way that, even if the fire has been kept very low during the night, in the morning it is possible for the attendant to get the radiators up to a mean temperature of about 180 degrees in less than an hour in ordinary winter weather. This temperature is kept only until the rooms are well heated. This generally takes but a few hours. After that time the pressure regulators of the boilers are set to close the drafts at about one pound pressure; then the action of the circulator ceases, and the apparatus keeps a sufficient heat in the building with a very low temperature of the water.

In mild weather it takes more than four days to burn one ton of coke in the heating apparatus. The consumption of coke during a whole winter is about 150 tons, this being about half a ton for each 1,000 cubic feet of space, or a little less than two and one-half tons for each 100 square feet of "Nominal" heating surface in the building. In other buildings heated by the same system, but less exposed than these, the consumption of fuel has been still lower.

Before concluding, I wish to make a remark: It would not have been possible for me, as a contractor, to develop this system of central heating, so that we are now prepared to undertake to heat at very long distances without using mechanical means, if it had not been for one thing. Some of the best Danish consulting engineers (including those engaged by the State and municipal corporations) very often allow contractors to tender for the work according to their own plans and on their own responsibility. Even if the engineers have themselves worked out detailed plans for the work to be executed, they are sufficiently open minded to recommend the adoption of plans proposed by contractors, if they can see any advantage in it for their employees.

I do not doubt that the rapid progress in methods of central



FIGS. 4, 5, and 6.—HOT WATER HEATING APPARATUS IN THE SCHIOLDANN INSTITUTION.

heating here in America is largely due to a frequent use of the same manner of procedure by consulting engineers of this country. I think it gives a stimulus to the self-activity of the contractors that is highly beneficial to the profession at large.

DISCUSSION.

Mr. Joslin: I would like to ask what is the proportion of heating done in the reheater B to the amount of heat units that is to be carried away in the water?

Captain Reck: About half of the full capacity. We supply our licensees with tables, from which they can take dimensions of mains and risers, that will give a temperature of 212 degrees in the flow pipes and about 160 degrees in the returns. I told you that the reheater B would reheat the water to about 185 degrees, which is about half the total heat lost.

Professor J. H. Kinealy: This valve *d*, how does it affect the working of your apparatus?

Captain Reck: I did not mention the valve *d* in the paper at all, because it has nothing to do with the system. It is only used if it is desirable to be able to shut off the circulator completely. In using the apparatus the circulator is always put out of action by letting the pressure go down in the steam boiler, when no steam will pass into the circulator, the immediate result being that the temperature of the circulating water is greatly reduced.

Professor Kinealy: The unique feature of this apparatus is in applying some of the heat at the highest point. What will be the effect on your circulation if you apply all the heat at the low point B?

Captain Reck: Then the apparatus would be transformed into an ordinary hot water apparatus with a reheater instead of a hot water boiler, but in that case you would not be able to get your water up to 212 degrees, and you would need as large mains and pipes as by the ordinary hot water system. Speaking about the small sizes we use for these mains and pipes, some people have thought that they would not be sufficient, when the circulation is produced by the reheater B only (without aid from the circulator). In practice we always have found them

sufficient, as they are, and the reason is, that in our case, when a good circulation has been started by the circulator, and when the building once has been well heated thereby, then the demand upon the heating apparatus during the rest of the day is not great, and small pipes suffice. They would not be sufficient if the circulation had been poor and sluggish during the morning hours, as very often happens by the ordinary hot water system. Moreover, all hot water engineers know that if a heating apparatus includes radiators in difficult places—and most apparatus does—then the difficulty is always to get the circulation started. This difficulty is overcome by the circulator C. It will start all the radiators at once, and when started they will go on nicely, even with small pipes. Speaking about supplying all the heat at the low point B, I would add that some competitors of our European licensees have tried to heat the water at the point B by an ordinary hot water boiler, and to such a temperature that the water will boil in the main rising pipe from the boiler without introduction of steam. It has been found, however, that in that case it is not possible to prevent steam being formed in the hot water boiler itself, so that the boiler really becomes a steam boiler instead of a hot water boiler. If you put a water gauge on such a boiler you will see the water level going very low, when the fire is strong, and you never can tell how far down it will go. But it is, of course, a very dangerous matter, when the water level can go so low down in a boiler that the water will not cover the whole fire surface. The bursting of such a boiler in a high building, where the temperature of the water, on account of the great pressure, would be apt to be very high, would produce very disastrous results.

Professor Kinealy: Have you tried cutting out the heater B and applying all your heat to the top of the system?

Captain Reck: Then you lose the advantage of being able to run the apparatus by low temperature by the reheater B.

Mr. Barron: I think that paper of Captain Reck's marks a decided advance in the art of heating. I have always advocated steam, but I am gradually coming to the belief that hot water is better than steam in most instances, particularly where you can use small piping. What we want to reach is a system of small pipe, small radiators, and high temperature. I think

Captain Reck's circulator is a very ingenious design, his reheater is all right, and with the two together, it makes a little complexity, so that I don't know whether it will be applicable to small work, but may be more applicable to large work,where you take the steam from boilers and apply it to heating water.

Mr. Barwick: How would that apparatus work in a tall building, for instance, one of fifteen stories?

Captain Reck: In such cases I would divide the building into three parts, five stories for each circulation system. If there was a steam engine in the building, I would run an exhaust main from the engine up to the attic and branch off to the reheaters and circulators from that main. It will give no difficulty in such cases to run horizontal pipes in the floors of rooms or corridors; 1¼-inch pipes will always be sufficient for that purpose. We have heated a castle with 90 large rooms in that manner. No horizontal pipe in that building is larger than 1 inch. I have also run a large steam main around the basement and then taken one circulator for each wing. If we have a building of three wings, we have three reheaters and three circulators. In that case the hot water mains are much smaller than if only one circulator is used for the whole building. In some cases we have gone nearly 500 feet with the hot water mains from the circulator. But in very large buildings we generally distribute the heat by the steam to several separate hot water apparatuses, each with its own circulator.

Mr. Barwick: The object, as I understand it, of putting in three sections and taking five floors in a section is simply a matter of diminishing the pressure of the water upon the apparatus?

Captain Reck: Certainly I should not like such high pressure when it is not necessary, but there is another point. You know in ordinary hot water heating there is a great difference in the velocity of the water between the lower stories and the higher. The use of my circulator removes almost entirely that difference, the velocity in flow pipes to indirect radiators in basement being only 10 per cent. less than in the flow pipes on third or fourth floors, but when the apparatus is to be run at low temperature by the reheater B alone, the distribution of the heat between the different floors will be better when the apparatus is divided in sections.

Mr. Davis: I notice you have the feed connection of the radiators at the top. Do you get better results in that manner?

Captain Reck: Yes, we find that the temperature of the radiators will be higher when you feed at the top.

Mr. Paul: You say you use in the Schioldann Institution per thousand cubic feet of space half a ton of coke, or a little less than two and a half tons for each one hundred square feet of nominal heating surface. How many days does that apply to?

Captain Reck: About 21 days. We usually begin to heat in the middle of September, and it runs to the middle of May.

I think you will find the consumption of fuel in the building very moderate, especially when you remember that it is much exposed to wind, that the rooms are ventilated, and that many of the inhabitants are old people, requiring a good deal of heat. Speaking about fuel consumption, then, anybody knows that ordinary hot water heating compares favorably with steam heating in that respect, but the adoption of the circulator system for hot water heating diminishes the consumption still further. From what has been said about the great velocity the circulator produces in the mains and about their small contents of water you will understand that the principal reason for that further diminution in consumption of fuel is that the circulator system is able to respond more quickly to all demands made upon it than the ordinary hot water system. This means, for instance, that in the morning the boiler can be left banked up at least one hour longer than if no circulator is used, and it means further that, once the heating of the building having got a good start, the whole heating apparatus can be very quickly cooled down again to such a point that no heat is wasted, even if the inhabitants leave all valves on the radiators fully open. One reason more for the low consumption of fuel is that the loss of heat from mains placed outside of heated rooms in attics or basements will be diminished when as by this system it is possible to diminish the sizes of such mains to half the diameters or less. Now some people think that if it is desired to keep a low fire in a boiler over night it must take less fuel to run an ordinary hot water boiler in such a manner than a steam boiler, even if its pressure is kept very low. On the contrary, we have found that low pressure steam boilers provided with a good

non-conducting coating and in combination with reheaters can be run over night with less fuel consumption than hot water boilers with the same area of grate. I think it is not very difficult to explain that. The inner walls of the furnace in a hot water boiler take more heat out of a low fire than the walls of a steam boiler, because the temperature of the hot water boiler is lower. The result is that you must keep a stronger fire in the hot water boiler than in the steam boiler if you do not wish to find the fire gone out in the morning. Thus in our case you will see it is an advantage that the cooled water has no access to the boiler proper but only to the reheater.

Mr. Snow: How is the current in the pipes accelerated by applying the heat at the topmost pipe, which is contrary to our practice?

Captain Reck: When the steam is introduced at C, suppose you have a pressure of three pounds in the boiler, then you will heat the water in C to nearly the same temperature as the steam. You would heat the water to, say, 220 degrees or so. As the water rises from C in pipe S the pressure will get less and less, and the water then cannot keep that high temperature. If you have atmospheric pressure in E the water here can be only 212 degrees, so the water has to cool down from 220 degrees to 212 degrees; and the cooling is done by the developing of steam bubbles in the water. The latent heat of the steam takes heat from the water. As I have explained to you in the paper, the specific gravity of the column S between C and E will then be about one-half of the specific gravity of the column T.

Suppose we take eight feet in height of this tube S between C and E. Then you will have four feet difference in pressure. You have four feet more pressure at T than at C. It acts just like a pump that pumps water from a level four feet lower at one place than at the other. The apparatus lifts the water up and runs it over into the pipe T, and the water comes back to the circulator, and is lifted again by the difference in pressure. Suppose you have an ordinary hot water apparatus on the two-pipe system and with a difference in temperature of 40 degrees between flow and return; you would then have only one and a half per cent. difference in specific gravity between the descending column and the rising column. To create circulation you

have in that case a head of only 1 inch of water for indirect radiators in basement, 2 inches for radiators on ground floor, and 2 inches more for each subsequent floor. In our case you will see that we have four feet head all over the building. Therefore not only will the velocity be greater, but the hot water will be much more equally distributed between the different floors.

Mr. Snow: Then in a sense the device C is an ejector: it acts as an ejector at the top of the flow pipe.

Captain Reck: It does—as a pump.

Mr. Lyman: Looking on the descending pipe L, there are in the Schioldann Institution something like ten radiators, to judge from the elevation, connected on a ¾-inch pipe. Will the specific gravity be sufficient to keep that water rapidly circulating with such a small connection?

Captain Reck: I think when the circulator is working the velocity in the pipe L will be about fifteen inches a second, so that if you calculate the British Thermal Units you will find that it will answer.

Mr. Mehring: In the apparatus described, what is the size of the steam pipe D?

Captain Reck: Two and one-half inches to the circulator.

Mr. Mehring: What is the amount of the superficial heating surface in the reheater B?

Captain Reck: About sixty square feet.

Mr. Mehring: What is the size of the pipe leading from F down into the boiler?

Captain Reck: About one and one-half inches.

Mr. Blackmore: Professor Kinealy suggested that it was contrary to the practice in this country to apply heat at the top and I want to bring out the fact that it was not applied only at the top, but being applied at the bottom and the top as well, the heat applied at the top does accelerate the circulation.

Captain Reck: That is just right.

Mr. Paul: The diagram shows the line of water in the boiler to be a certain height. I would like to know where the line of water is in the return pipe from the condenser F. There is no water line shown.

Captain Reck: You will have a water line in the return pipe from F, so that the height of that water line above the water

line in the boiler will be about the same as the height from C to E.

Mr. P[illegible]: When you start do you have any water in E?

Captain Reck: Oh, yes. The water in the expansion tank is always kept to the level of the overflow. The water in the hot water apparatus is one thing, and the water in the boiler is another. These two contents of water are quite different. You always have the same water line in the tank E, up to the overflow.

Mr. Mehring: What would be the effect if the circulator C was placed in the first story? Would the circulation be faster?

Captain Reck: If you took the circulator C lower down below the tank E then you would have to carry a much higher pressure in the boiler to get the steam to penetrate into C. The boiler would no longer be a low pressure boiler; it might be difficult to get the condensed water back into the boiler; and there would be no benefit by the slight increase in velocity of the water that might be the result. We have small pipes now, and there is no reason for having them still smaller. For instance, I should not advise any one to use less than half-inch pipe for risers, and that is what we use now in many instances.

Mr. Mehring: What is your practice in regard to the length of the pipe S between C and E? What is its usual length?

Captain Reck: We have formulas that give the height of the pipe S between C and E in proportion to the height of the building and the length of the mains, both things coming into that formula, but they are only given to our licensees.

Mr. Barron: Would it make a difference if the circulator were in the expansion tank?

Captain Reck: You must have a pipe between the circulator and the expansion tank to produce a head.

Mr. Barwick: If there is an increase in the temperature of the water, there is an increase in the expansion of the water. Where does that go?

Captain Reck: In our case it is best always to use a steam boiler that admits of a variation of a couple of inches in height of the water line. Suppose you started the apparatus filled to the level of the overflow in E with cold water; the expansion of the water would give you more water running down the overflow M than is condensed when you begin the heating,

and the opposite is the case in the last part of the day, when the heat is going down. Then some of the water in the boiler will stay in the hot water apparatus, because the water contracts. I always recommend not to use a boiler with too small a steam space. However, I have found that our licensees have used some American boilers with very small steam spaces without having experienced any bad results.

Mr. Snow: About what are your maximum velocities?

Captain Reck: Our mean velocities are about 14 to 15 inches per second. We use very different velocities in the horizontal mains, both in the flow mains and in the return mains. In the first part of the system we use rather high velocities, but in the last part of the system much less.

Professor Kinealy: I would like to ask some questions about the diagram Plate 2. Take the temperature 160 degrees for line I, the coefficient is 1; and at the same temperature for line IV, the coefficient is 2. That is to say, that one square foot of indirect radiation surface when the air is heated to 68 degrees, will emit twice as much heat as one square foot of direct radiation, 38 inch 2 column radiator.

Captain Reck: Exactly.

Professor Kinealy: What is the temperature of the air coming into that radiator? Is it zero or 4 below zero?

Captain Reck: About zero.

Professor Kinealy: What kind of radiation is that?

Captain Reck: Plain radiation. I would say that these lines I to VI represent mean results and cannot be exact. In your boiler catalogues in America it is customary to state that indirect radiation shall be counted as one and one-half times as much as direct radiation. Here the air is supposed to be heated to about 120 degrees F. and that corresponds just to curve III in the diagram.

Professor Kinealy: When the air is blown by a fan, as indicated in line IV, the coefficient is three and one-half.

Captain Reck: Yes.

Professor Kinealy: That is to say, air entering at zero, passing over a smooth indirect heater, and leaving the heater at 68 degrees, then the heater will emit three and one-half times as much heat per square foot of surface as a direct radiator?

Captain Reck: In the mean I think so.

Mr. Snow: It is your common practice to place your radiators as shown in section C D of the Schioldann Institution along the inner walls of a room?

Captain Reck: It is mostly the practice to place the radiators under the windows. In this building they are placed on the walls, because the owner wished them there.

Mr. James Mackay: The idea seems to prevail that the heat in Captain Reck's diagram is applied at the top. I think that accelerator that he shows there is simply to accelerate the circulation.

One thing that strikes me is the lower floor radiator on a line below the boiler. I imagine the temperature in that would be a little below the temperature in the ones above, and I would like to ascertain whether, if the surface were increased, or if there were a great many radiators on the lower floor, they found that the circulation or temperature of these radiators was not lower than the ones above.

Captain Reck: We generally prefer the one pipe system as shown in diagram, and we then arrange the mains and the risers in such a manner that the temperature of the lowest radiators will be about 160 degrees F. Of course, by the one pipe system the temperature of these radiators is lower than the temperature of those on the upper floors. On each floor it is lower than on the floor above. On the contrary by the two pipe system the temperature of the radiators on all floors will be the same (about 185 degrees). I hope to be able to show you a demonstration of the apparatus in the office of the American Radiator Co. here, perhaps to-morrow morning. We shall have such a radiator in the basement, so that all those who are interested in the subject will be able to see there how the temperature will be.

Mr. Joslin: A system to be practicable must be elastic in its adaptation. Suppose it was necessary, after you had laid out an apparatus with these risers, to change some of the partitions and increase the size of some of the rooms, then you would necessarily have to increase the heating surface. Suppose it was increased 15 or 25 per cent.; what effect would the increased surface have?

Captain Reck: The only effect would be that the drop in temperature in such a riser would be 15 or 25 per cent. greater

than in the ordinary risers so that you would have to calculate the heating surface in these risers greater compared with the heating surface in the other risers in the same proportion. You have about the same quantity of water running down the riser as formerly, but it will be cooled more, so that the temperature in the riser on the lower floors would be less than in the other risers. But there would be no difficulty as long as you do not go too far.

Mr. Joslin: In adding on to your surface, you would not only have to add surface enough to make up for the increased surface of space heated, but also for the diminution in the temperature of the water.

Captain Reck: Yes, sir.

Mr. Barron: Most of us are familiar with the so-called Evans system, using exhaust steam. This is the same system, I take it, using live steam, with a circulator and condenser added. If I am wrong I want to be corrected.

Mr. Barwick: Evans' system depends largely on the circulation of the water by means of a pump, not only upon the circulation of the heat. The idea of putting a coil into the upper part of the building is simply, as I understand it, as a reheater to reheat the water and increase its temperature at a distance away from the boiler, or, rather, from the main heater in the stack. But the Evans system is practically the circulation of water by means of a pump.

Mr. H. McKeiver: Does the steam passing into the circulator make any noise in passing into the body of water?

Captain Reck: No, sir. We have found a mixing device to do it so that there is no noise.

Mr. McKeiver: Is there any provision there for excess of pressure?

Captain Reck: The employment of a low pressure steam boiler for heating the water prevents any excess of pressure. We use, of course, a safety valve on the steam boiler, so that you cannot have a higher pressure than is allowed by that safety valve. Three to five pounds pressure always suffice, and in small installations one or two pounds will do.

Mr. Paul: As the pressure goes down in the boiler, that pipe that conveys the steam up to the circulator would cool and in cooling would produce a minus pressure, that is, a vacuum?

Captain Reck: Yes, sir.

Mr. Paul: Would that have a tendency to draw the water out of the system back into the boiler?

Captain Reck: Yes, it would; but we employ a valve, a common check valve, in the top of the steam pipe that introduces air in the steam pipe if a vacuum is formed.

The President: Are there any more questions to ask the Captain?

Mr. Paul: I certainly think the Society has received in this paper a very fine contribution to its literature, and I feel that for myself at least I desire to thank the Captain for the paper before us.

CXXIII.

THE METRIC SYSTEM.

BY CHARLES F. HAUSS, ANTWERP, BELGIUM.

(Member of the Society.)

Four years' residence in Europe, and the constant use during that time of the metric system of weights and measures, convinces me that America should no longer be without it.

We say, "Time is money," and spend on labor or time saving machinery fabulous sums of money, yet we waste fortunes every year in the time used in manipulating the absolutely ridiculous system of weights and measures that we copied from England.

At the present time the United States and England are the only two civilized nations on earth who have not adopted the metric system, and I am sure that so soon as we adopt it, England will follow us.

So many Americans, and I regret to say, many who should know better, are under the impression that all our weights and measures are the same as England's, and claim, therefore, that there are so many English-speaking people as to afford this system of their own, but as a matter of fact our quart and gallon are 17 per cent. smaller, our bushel holds 3 per cent. less and our hundred weight and ton are 12 per cent. lighter than England's.

This difference may have been the result of shrewd Yankee reasoning, when our weights and measures were devised to get 17 per cent., 3 per cent. and 12 per cent. the best of the other fellow.

The metric system is so far ahead of the English system, as our system of money is better than the ridiculous money used in England where:

4 Farthings make 1 Pence
12 Pence " 1 Shilling
20 Shillings " 1 Pound

At a former discussion one of our members opposed the metric system because it was so easy to figure, and though he explained to me later that he was only joking, this bit of a joke cost him all the reputation he ever had as an authority, in the estimation of European engineers. Hence, I hope the matter will be seriously discussed, and that our Society will come out boldly for this progressive system of weights and measures.

We lead in nearly everything; we are the people of progress, yet we hang on to an antiquated system of weights and measures now no longer defensible than would be the "Prairie Schooner" as a means of travel between New York and San Francisco to-day.

That we have not made the change is to the European engineer a source of wonder.

The metric system must come in time, and every year of delay will make the change cost us more.

To those not conversant with the system I would say:—

The metric is a decimal system, the meter being the basis of all measures, whether of length, surface, capacity or volume. It measures 39.37 inches and is theoretically one ten-millionth of the distance from the equator to the pole. Where the measurements are too great to use the single unit, multiples of the unit are used, and are indicated by the Greek prefixes of *deca*, *hecto* and *kilo*, indicating respectively tens, hundreds and thousands. When the quantities are so small that the unit cannot be conveniently used, decimal parts are taken, and are indicated by the Latin prefixes *deci*, *centi*, and *milli*, meaning tenth, hundredth and thousandth, as illustrated in the following table:

1 millimeter	equals	$\frac{1}{1000}$	meter
1 centimeter	"	$\frac{1}{100}$	"
1 decimeter	"	$\frac{1}{10}$	"
1 meter	"		
1 decameter	"	10	meters
1 hectometer	"	100	"
1 kilometer	"	1000	"

In all measures of length the meter is the unit, and like the English yard is used in measuring cloth, pipe or moderate distances or dimensions. For long distances, like the mile, the kilometer is used, and for short or minute distances, the centi-

meter and millimeter are used. The customary abbreviations in the measures of length are:

mm. for millimeter.
cm. " centimeter.
dm. " decimeter.
m. " meter.
km. " kilometer.

Measures of surface are derived from measures of length; the unit is the square meter, and as a surface area is the product of its length and width, a square centimeter would equal 100 square millimeters. Hence the following:

100 square millimeters, 1 square centimeter.
100 " centimeters, 1 " decimeter.
100 " decimeters, 1 " meter.
1,000,000 " meters, 1 " kilometer.

The square meter is used liked the square foot in measuring small areas—ceilings, floors, walls, etc.

Cubic measure is constructed in the same way, remembering hat a cube is the product of the length, width and height. The unit is the cubic meter which, like the cubic foot, is used for measuring the contents of rooms and in place of the cubic yard in measuring excavations, etc. Cubic centimeters and millimeters are used for minute bodies.

Measures of capacity are based on the cubic meter; but as the cubic meter would be too large and unwieldy for ordinary purposes, the cubic decimeter was adopted and the name liter given to it. The liter is equal to 1.0567 quarts, and is used like the quart or gallon, multiples forming the larger and decimal parts the smaller denominations, as follows:

10 milliliters equal 1 centiliter.
10 centiliters " 1 deciliter.
10 deciliters " 1 liter.
10 liters " 1 decaliter.
10 decaliters " 1 hectoliter.
10 hectoliters " 1 kiloliter.

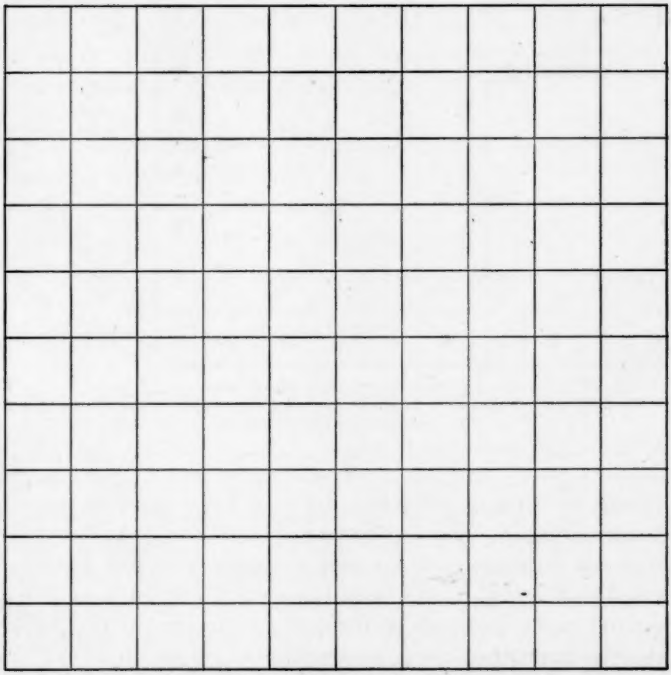
The hectoliter (2.838 bushels = 26.417 gallons) is used like the bushel or barrel.

The unit of weight is the *gram* (15.432 grains) and is the weight of one cubic centimeter of water at its greatest density about 39 degrees Fahrenheit—the decimal multiples thereof

being used instead of ounces, and the kilogram = 1,000 grams, being used like the pound.

Figs. 1 and 2 will better show the simplicity of the system. Not many years ago Germany used feet and inches, and I

The above cut represents the decimeter with its divisions, centimeters and millimeters.

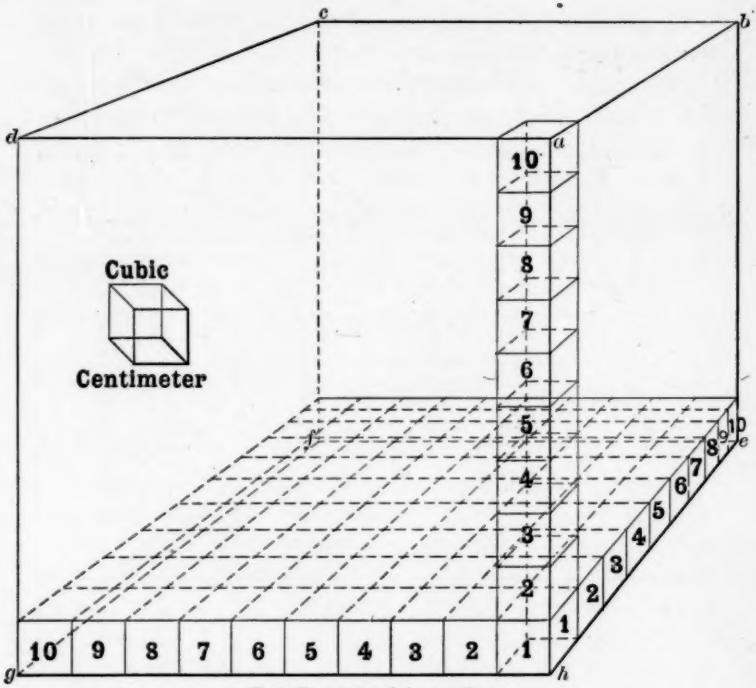


The above cut represents the square decimeter with its division into centimeters.

FIG. 1.

attribute much of the German's success in reaching first place in science generally, and the theoretical knowledge of heating particularly, to the use of the metric system.

For the heating engineer to figure surfaces or cubic contents it is very much easier to do so with the meter and its decimal parts than with feet, inches and fractions.



CUBIC DECIMETER, ⅛ ACTUAL SIZE.
The above cut represents the cubic decimeter, the unit for the liter and kilogram; and the cubic centimeter, the unit of the gram.

FIG. 2.

Take, for example, the heating of a large tank of water or swimming basin, what an amount of labor is necessary to figure the cubic contents in feet; then translate this into gallons or pounds—whereas if you have the contents in meters and the decimal parts, a simple shifting of the decimal point gives at once the number of cubic decimeters, which means at the same time the number of liters, or the weight in kilograms, as a cubic decimeter or liter, or kilogram of water are the same amount, expressed in cubic contents, liquid and weight respectively.

For measuring gauge pressures we would then naturally do away with pounds per square inch and use the kilogram per square centimeter, which is exactly one atmosphere; and as one atmosphere of pressure is equal to practically 10 meters of water column, each $\frac{1}{10}$ atmosphere of pressure is used in practice as equal to one meter of water column.

From every point of view the metric system is the logical one that nearest conforms with nature.

I would further advocate the use of the Centigrade thermometer, now in general use all over Europe, and the one used exclusively by scientists as being the most naturally arranged.

The divisions being based upon the metric system, the figures are much more readily handled than those of the Fahrenheit thermometer.

In this thermometer zero is the freezing point, and 100 degrees is the boiling point.

With this change would come naturally the continental calorie or heat unit (3.96 B. T. U.), which is the amount of warmth necessary to heat one liter or kilogram of water one degree Centigrade.

We would then have a rational system of weights and measures, and could meet the whole engineering world on common ground, to discuss matters that now require such laborious translations as to make an interchange of ideas or papers prohibitive.

DISCUSSION.

The President: You have heard the reading of the paper, and it is now open for discussion.

Mr. Barron: I am in favor of the metric system, and I think that this paper of Mr. Hauss' will have an influence and a bearing that we cannot estimate to-day. Possibly no subject is of greater importance to the producing world to-day than the adoption of the metric system. And its adoption is retarded purely by prejudice. When we get right down to it, we are all Philistines. We all believe that we alone are right. And that is particularly true of the British and the American nations. If you undertake to compute the influence of the British people in the world, you can say there is a hundred million of them, and of the American people a hundred million more, with its outlying possessions; that is, two hundred million people in all. They have a system which is virtually the same, that is, they are opposed to the metric system. And it is the only opposition to the metric system in the world; the rest of the world is ready to adopt it. Take the Latin peoples, France, Spain,

Italy, Latin countries, have adopted the metric system; and the Germanic countries have adopted the metric system, and they use it. The Latin peoples, I should say amount to one hundred and fifty million people, and the Germanic people to one hundred and fifty million people; and it is ridiculous that two hundred million people should undertake to dictate to three hundred million people. However, I believe that the metric system is bound to come, and I hope that this Society will put itself on record as in favor of it. The system is scientific. It is just as Mr. Hauss explained it, and right thinking people are adopting it. The American people ought to go in with the French and Germans and adopt it, and the English people will adopt it also. I am a disciple of the late Herbert Spencer, and he left a fund to fight the introduction of the metric system in Great Britain. I think that is a case where a great man has made a mistake. I think he was wrong there, although he may have excellent reasons for the course he has adopted, and they may be produced here this afternoon, but I have never read them. The adoption of the system would have a humanizing effect. It would mean that you are going to do business in a friendly and proper spirit with your French and German neighbors; but as long as you keep a separate system it is like a prohibitive tariff, or a system which says: "We won't deal with you; we don't want to talk with you in your own language." I think that tendency among the British and American people is wrong. The spirit of the world to-day is to get together.

Professor Kinealy: I voted against the metric system both in this Society and the American Society of Mechanical Engineers. It is possible, therefore, that I am one of those ignorant fools, or perhaps one of those great men who have made a mistake. (Laughter.) I think we should bear in mind that the metric system was put upon Europe by Napoleon, just exactly as the German language has been put upon the provinces of Lorraine and Alsace by the German Emperor, not because the people wanted it, but because they could not help themselves. There is a law now allowing all who desire to do business in this country by the use of the metric system to use it. But we are tied to the past, as some one has said, absolutely tied hand and foot to the past by our English system of weights and measures.

And so much are we tied to the past that in a bill introduced in Congress they excepted from the obligation to use the metric system all measures pertaining to land. And why? For the simple reason that you cannot go back and copy and change and recalculate the records on file all over the country in the United States. I have been in Texas, where I made surveys, and we did not state our areas in square feet or acres, but in varas. The vara is the old Mexican-Spanish measure, and to change it and use the English unit would require the changing of all the records in certain parts of Texas. In Missouri, in certain parts of the State bordering on the Missouri River, parts that were settled by the old French, we still have and use and put on record the old arpent instead of the acre, and to change that to English units would mean to change all the records in those parts of the country. If we make the metric system obligatory, we shall have to discard all of our books, and all of our tables relating to different subjects, and all of our literature on some subjects that we have accumulated for hundreds of years past must be retranslated, or in one or two generations be almost unintelligible. The argument is often made that it is so much easier to use the decimal system. I cannot see how it is any easier to multiply 23 by 28 feet than it is to multiply 23 meters by 28 meters. It is exactly the same thing, and if you are going to change from meters to decameters or decimeters, you will have to be very careful what you say, or you will get your Greek and your Latin mixed. Of course you can divide by ten or multiply by ten by simply changing your decimal point, and it is only in such cases that your computations are easier. Where you have to multiply numbers that are not decimal numbers, where you have to multiply or divide by something other than ten, one system is just as difficult as the other, at least so far as I can see, and I have used both. Further, it means that in all shops and all manufacturing establishments, where standard gauges have been made and used for years, the gauges must have their names changed at least. That would not be very difficult, perhaps, but it would be rather difficult to change the inch into its exact decimal equivalent, according to the metric system. You could not have any particular unit in the decimal system equivalent to the inch, or you would have a long number con-

sisting of several figures and a decimal point. While I do not think there is any opposition on the part of those who voted against the metric system to the rest of you using that system if you choose, we do object to being obliged to use the metric system when the other is so much easier for us at present. And that, I think, is the whole argument. I don't think the metric system is practically better than our system. On the other hand, I do not think that the British system is practically better than the metric system.

I cannot see, as I have said before, any of the great benefits that are going to come from the adoption of the metric system. It is possible that manufacturers may be able to do business with foreign countries more easily by means of it, but I am sure there is not a manufacturer in this country who, if he found that he could do business with Europe or with South American countries, by making his drawings or his machines according to the metric system, but would do so. (Applause.)

Mr. Blackmore: I am glad that this paper was read before the Society, and I want to go on record as being in favor of the metric system and having it adopted just as quick as we can get it. And I want it only and solely because of its simplicity and utility, and its adaptability to almost every purpose for which things are designed. There is probably just as much difference between the metric system and our system as we shall find if we compare our monetary system with that of England. We use the decimal system in this country in our monetary system. It is very simple. The British still cling to their old system of pounds, shillings and pence, and, while we do adjust ourselves to that system in dealing with England, we do find a great deal of difficulty in doing so. But if we both had the same system of currency it would be a great deal easier for both. Professor Kinealy started out by saying that the metric system was something put upon us by Napoleon. I don't see any reason why we should not use a good thing, even if it came from Napoleon. I think that Napoleon did a great many good things for the world and, though he gave us some bad things, we do not necessarily have to use the bad because we take the good.

As to our land records, it is stated, though I don't know it as a fact, that we are using the Mexican system of land measures

in Texas yet because it is easier. If it is easier to use the metric system of land measures in our records, why not do it, the same as we use the Mexican measures in Texas? It would not complicate matters as I can see. The whole thing should be tried on its merits. Is it a simpler system? The fact that we are trading more and more with foreign countries makes it all the more necessary that we should adopt some uniform system of weights and measures, and I don't think we can do better than to adopt the metric system. If we were adopting it out of pure compliment to Europe, and it was not as good as ours, I should consider it folly. But they are not putting anything on us, neither are we trying to force ours on them. They simply have got a better system of weights and measures than we have and it is high time we adopted it. The British people are very slow to make changes, and very largely for the reason which Professor Kinealy sets forth. They don't want the bother of changing. It is easier for the present generation to get along as they are. But we ought to be broad minded enough to look a little into the future. When our children are educated to the metric system it will be as easy to them and easier than the present system is to us; and for the sake of the benefit to the rising engineers I think we should put a little extra work on this generation. If we make the change I think posterity will thank us for doing so.

Mr. Harvey: I think it is a well-known fact that most of the tool-rooms of the larger machine shops in the country use the metric system now for all their measurements in respect to their finer tools. I am very positive that is the case in the larger number of good tool-rooms.

A Member: Is it not true that as civil engineers do not use the inch as a fraction of a foot, but the tenth of a foot, that that is an adaptation of the metric system?

Mr. Snow: The thought that ran through my mind during this discussion was based on a suggestion made by Captain Reck, that slide rules were commonly used on the other side. Now the slide rule is a device which ought to be more generally adopted by engineers, and a great saving of time would result. They are made out, however, on the decimal scale, and when one attempts to use one in computing the contents of a given space, for instance, if he has a room that is 25 feet 7 inches

long, he must reduce that seven-twelfths of a foot to a decimal before he can use his rule. Whereas, with a decimal system, he would find the length directly on his rule. I believe that all such figuring could be much more readily done on the decimal system, that is, on a system using decimal fractions, for the same reason that our system of money is very much simpler than that of England. And it seems to me that the chief advantage that would accrue to heating and ventilating engineers from the adoption of this system would be in the greater ease afforded in making calculations, especially if slide rules are used, as they commonly are in many offices.

Professor Kinealy: May I ask Mr. Harvey a question, please? You stated, I think, that in all the large shops——

Mr. Harvey: In many large shops.

Professor Kinealy: Do you not mean the decimal system instead of the metric system? Is it not inches and hundredths of an inch and thousandths of an inch rather than meters? What distillery is there that sells whiskey by the liter?

Mr. Harvey: I am not posted in that line.

Professor Kinealy: What pipe mill in the country is there that sells pipe according to the meter and decimeter and the decameter and the kilometer?

Mr. Harvey: I don't know much about pipe mills.

Professor Kinealy: I know of plenty where they use the decimal system and take an inch and divide it up into hundredths, thousandths and ten thousandths, but that is different.

Mr. Harvey: I can refer to a case where we had a number of things to make for the car shops, and all their blue prints that were sent to our shop were in the metric system.

Professor Kinealy: In meters?

Mr. Harvey: In meters, yes; and I had a little difficulty at first, and had to get measures of that kind, and I know something about what I had to do. That is why I knew it so well.

Mr. Baldwin (a guest): My business has been that of a pattern maker, and I have come in contact with drawings of the United States government, largely in the work of an arsenal in Massachusetts, and all of the United States government drawings are figured in the decimal system; all the work in the Navy Department, and all work for the army, in the building of large guns, for instance, is figured in the decimal system. I

was also employed within three years with the largest shoe machinery manufacturing concern in the world, the United Shoe Machinery Company, and when I left the employment of that concern it was then perfecting a system by which all the jigs and special tools for that concern were to be figured in the decimal system. The tool makers throughout the country have found it necessary to have two sets of rules, one figured in eighths, sixteenths, thirty-seconds, sixty-fourths, and the other in tenths, hundredths, thousandths; and I think, as Professor Kinealy has well said, that all our large machinery manufacturing concerns throughout the country are adopting gradually the decimal system, but not the metric system.

Mr. Blackmore: I don't quite agree with Mr. Harvey in saying that it is not a good thing for us to discuss. I think it is. And I think if we discuss it a little longer it will develop a good deal of heat, and if it don't it will stand a good deal of ventilation. There was a tendency in almost every discussion at which I have attended where this question has been brought up to bury it, not to bring out all the facts in connection with it. I think it is a matter we ought to think over. It would be a distinct advantage for the progress of this country, especially for its educational methods, if we should change our system of weights and measures, and also do away with the Fahrenheit thermometer, which is a great anachronism. I hope the matter will be well thought over, though I don't know that we can take any action any more than to ventilate the subject.

Professor Kinealy: Just one word more in line with what has been said, and that is this: The men who are content to use the weights and the measures and the books and the records of the past are keeping still, while those who want to use something else have been protesting. There is not a man in this Society or in the City of New York who would say that if a man wants to make an agreement to sell me butter or eggs, or what-not, according to the metric system, and I desire to do so, that he and I have not a perfect right to do so. But I, for one, am opposed to passing a law telling me that I shall not use the records of the past, that I shall not use any of the books on the sciences that have been printed in the past, unless I translate them into the metric system. We are content. The other persons seem to be worrying.

Mr. Barron: I believe with Professor Blackmore, and even with Professor Kinealy, that we do not have to do anything of the kind proposed. No one intends to change our system immediately to the metric system. We don't want to force our fellow men to adopt this system immediately. It will be a matter of growth. But we want to be prepared to accept it intelligently and consider it well. The discussion I listened to in the Mechanical Engineers' meeting was interesting. A machine shop superintendent got on the floor and said that they got an order from Germany in the metric system, and he sent the drawings and passed them up to the head draughtsman. The draughtsmen went over them, changed all the drawings and computations, and they figured that they would have to build a special machine, and they made estimates for a special machine. The firm were anxious to get one of their lathes, and when it got into the shop the superintendent said that he gave it to one of their Irish machinists to look at, and this fellow says: " This is our regular No. so and so." The superintendent had not discovered it, and the head draughtsman hadn't discovered it, but he said that it was one of their regular standard machines. The Germans had one of these lathes in Germany, and made the measurements in the metric system, and sent back to this company for a duplicate machine. This simply shows that it is not going to be so extremely hard for us to change. We will change gradually and slowly. I don't think that I could personally learn in five years to use the metric system, possibly not in the rest of my life. But we want to intelligently discuss the system, and accept it, if it is a good thing, as far as it goes.

The President: If there is no further discussion on this subject, I would like Captain Reck to close this discussion. He is conversant, of course, with the metric system, and he has had some trouble probably and some experience in connection with our system of measurements in getting up his tables, etc. I believe it would be of interest to hear his experience in the matter.

Captain Reck: We, in Denmark, are behind the other countries in Europe; we are not using the metric system. (Laughter.) We have so many relations with England that we keep quiet and look out for their trade. Personally, I do not

like the metric system. I find it is much easier to get the area of a two-inch pipe in square inches than in square millimeters, for instance. Before you can get the area of a pipe in millimeters you can do it much easier by the square inch. There has been much talk about the facility of calculating the contents of a volume of water in the metric system. But if you have your units in your head, you can get very easily to the contents of the volume of water if you use inches. Your President has suggested that it has been some difficulty for me to compute my tables first according to the rules used in Denmark and then afterwards to translate them into English, but after the work has been done once I think is is as easy in one system as in the other. I think every engineer can very easily go in a scientific work from one system to the other; and, as Professor Kinealy has said, there are so many small things that would be very difficult to get over if we went over to the metric system. So I must confess that we are in that respect behind in Denmark.

Professor Kent: The principal part of Mr. Hauss' paper is taken up with an elementary description of the metric system for the benefit of those not conversant with it. There are few intelligent people in the United States between the ages of twelve and forty years who are not perfectly familiar with the description of the metric system given by Mr. Hauss. For the last twenty or twenty-five years the system has been taught to every child in the grammar schools of the public school system of the United States. There is probably not a school arithmetic published in that time that does not contain a full description of the metric system and numerous exercises in conversion of English into metric measures and *vice versa*. The fact that the American people have not adopted the metric system is not because they are not familiar with it, but because they do not believe that it is as well suited to their purposes as the English system. The people have had ample opportunity to become acquainted with it through other means than the public schools. For thirty years or more there have been societies actively engaged in a propaganda of the system, and every year or two a bill has been introduced in Congress for the purpose of forcing the system on the people.

In 1866 a bill was passed legalizing the use of the metric

system, and since that time people that wished to use the system have been at liberty to do so. Within the last ten years renewed efforts have been made to force this system on the people. In 1896 a bill was introduced in Congress providing that after the first day of January, 1901, "the metric system of weights and measures shall be the only legal system of weights and measures recognized in the United States." The bill failed to pass. In 1902 a similar bill was introduced, but the word " only " was left out, so that it read, " The metric system shall be the legal standard of weights and measures used in the United States." That bill did not attempt to compel the people to use the system, but only made it compulsory on the departments of the government to use it after January 1, 1904.

During two years hearings in favor of and against this bill were had before the Commitee of Coinage, Weights and Measures. In the first year a tremendous effort was made by the advocates of the metric system to have the bill reported, and it appeared that they were likely to succeed, but then the opponents of the metric system woke up and brought their arguments with such force that the Committee failed to report the bill.

The agitation has extended to Great Britain also, and after many years of effort it appears that the House of Lords has at last passed a bill in favor of the metric system, but the bill will likely fail in the House of Commons as such bills always have failed heretofore. " The persistent efforts of the advocates of the French metric system to get it enforced in the British Empire have brought into being the British Weights and Measures Association, whose primary object is to combat the meter." I quote from the pamphlet issued by the Association, the executive committee of which is composed of the heads of some of the most important engineering concerns in Great Britain.

The agitation in this country during the last few years has resulted in an overwhelming defeat of the metric advocates. It has also resulted in the publication of standard literature antagonizing the system, among which are papers by George W. Colles in " Transactions American Society of Mechanical Engineers," Volume 18, and by Frederick A. Halsey in Volume 24; a book entitled " The Metric Fallacy," by Halsey and Dale,

published by D. Van Nostrand Co.; also a bipartisan metric and anti-metric report of the Committee of the American Society of Mechanical Engineers, consisting of Messrs. James Christie and Fred. J. Miller, in favor of the system, and George M. Bond and myself against it. The report is published in volume 24 of the "Transactions of the Society."

At one of the hearings before the Committee on Coinage, Weights and Measures I had the opportunity to present an argument against the adoption of the metric system by the government departments, and I will ask leave to place an abstract of my arguments on that occasion in the Proceedings of this Society as part of this discussion.

WHY THE ADOPTION OF THE METRIC SYSTEM BY THE PEOPLE OF THE UNITED STATES IS IMPOSSIBLE.

By Prof. William Kent, of Syracuse University, before the House Committee on Coinage, Weights and Measures, March 18, 1904.

I first became acquainted with the metric system nearly forty years ago, when I was a student in the Central High School at Philadelphia. It was then being introduced into the public schools, and a considerable public agitation was made about it, so that I became quite familiar with it. In 1875-76, when I was a student of chemistry and engineering in Stevens Institute, I had frequent occasion to use it; and in my work as assistant to the United States Board appointed to test iron, steel, etc. (1875-77), I used it to some extent both in weighing and in measuring. Some of the professors in that Institute were strong advocates of the system, and I became an advocate of it myself, so much so that I wrote some articles in the "American Manufacturer," of Pittsburg, in 1877-78, when I was editor of that paper, in favor of it. In 1880, Mr. Wm. Metcalf, who was then President of the Engineers' Society of Western Pennsylvania, asked me to write a paper for the Society attacking the metric system. I replied to him that I could not very well do that, as I was on record in favor of the metric system. He said, "All right, write a paper in favor of it, and then we will attack you." I consented, and wrote a paper which is published in the first volume of the Proceedings. In preparing that paper I read all the literature I could find on the subject and in it I gave the arguments on both sides. The result of my investi-

gations while preparing the paper are expressed in its concluding paragraph, which is as follows:

"If my hearers now think that I have only 'straddled' this question and not planted myself as firmly as they could wish on one side or the other, I will now define my position. I think that theoretically the metric system is a very good system. Practically it is practicable in some things, impracticable in others. In regard to government interference, I hold about the position of Ensign Stebbins on the Maine liquor law: He was in favor of the law, but opposed to its enforcement."

DIFFICULTIES OVERWEIGH THE ADVANTAGES.

The paper itself will show that my investigations of the metric system led me to realize the fact that the difficulties in introducing it were so great as to overbalance its advantages. The paper, however, was considered by Lieutenant F. A. Mahan, U. S. A., who was then a member of the Society, to be so antimetric that he wrote a paper in favor of the metric system, apparently as an antidote to it.

The concluding page of his paper contains the following:

"The schools of science all through the land are teaching the metric system, many of them having adopted it exclusively. The graduates of these schools will be the directors of the future, and they, knowing its advantages, will bring it to the front. Engineers will demand it and manufacturers must yield to it or be left behind in the race. Those who have used the system enough to understand it thoroughly, who have a knowledge of it gained from everyday use, and all who have seen its convenience in every direction, are in its favor. The opposition is mainly made up of those who, in the words of a prominent member of our Society, 'don't know and don't want to know anything about it.'"

In the twenty-four years that have elapsed since Lieutenant Mahan's paper was published his prediction of the adoption of the metric system by engineers has not yet come true. The graduates of the schools are the directors of the present, and they have not brought the metric system to the front. Engineers do not demand it, manufacturers have not yielded to it, and they have not been left behind in the race. On the con-

trary, since the paper was written the manufacturers of the United States have advanced this country to the position of the first manufacturing country of the world.

Let us turn from what Lieutenant Mahan, now Major Mahan, said in 1880 to what he said in the latter part of last year. The "American Machinist" of January 14, 1904, reporting Major Mahan's discussion of the metric system at a meeting of the Société des Ingénieurs de France, says:

"In 1876, Major Mahan came to France, where he spent three months in studying the interior waterways. His studies gave him a great deal of experience with the metric system, the value and convenience of which he soon realized. Since then he has employed it a great deal, and above all when he had difficult computations to make. Often he has converted his American data into metric terms; made his computations, and reconverted the results. By this means he has often realized an economy in time of 50 per cent.

"But, on the other hand, the mind had an inertia that it was difficult to overcome. Although he was a great partisan of the metric system, and had employed it largely for thirty years, he had always experienced great difficulty in thinking in that system. When stresses of so many kilogrammes per square centimeter were mentioned, no idea was conveyed to his mind, and he found it necessary to convert them into pounds per square inch. It was very difficult for Americans who had the habit of the latter form of expression, and who heard no other about them, to understand at once what was meant by measures expressed in kilogrammes and centimeters. This form of expression frightened the American people a little, because they did not understand it, and it was difficult to make them appreciate the great advantage of the metric system over the one actually in use."

Thus we find that Major Mahan himself, with thirty years' experience of the system and a public advocate of it twenty-four years ago, to-day finds it difficult to think in the metric system. How, then, can we expect the American people, who have not had the same advantages that Major Mahan had, to think in that system?

Since the preparation of my paper in 1880 the results of my observation and study for twenty-four years have only con-

firmed me in the opinion that I expressed in that paper, that the difficulty of introducing the metric system into America is so vast as to make it an impossible task. I said in that paper:

"Yes; first establish an international money system, successfully accomplish the reform in the spelling of the English language, teach all the nations of the earth to speak one universal language, or do any other desirable but herculean labor which finds its chief hindrance in the habits, traditions and prejudices of millions of the human race, and you may be prepared to undertake such a revolution as would be the substitution of the meter for the two-foot rule."

The difficulties which then, in 1880, hampered the introduction of the metric system have since that date increased many fold. Mechanical engineers and manufacturers have explained the impossibility of wiping out the English system in our machine shops, and others have argued other phases of the subject. I wish to touch on only one phase which has probably not been considered to any great extent by the men who have hitherto appeared before this Committee. I refer to the inconceivable magnitude of the task of wiping out or translating into metric measures the English literature based on the English inch and foot, and the enormous number of records in manufacturing establishments based on the English measurements. I read in the "American Machinist" of January 28, 1904:

"The vaults of the Bucyrus Company contain about 20,000 tracings made through a period of perhaps twenty years. Of the full-sized sheets perhaps 1,500 are liable to be used on new work, while at least 8,000 of the small sizes are still alive. It is evidently impossible to consider any system which does not provide for using these old drawings."

When it is considered that every one of these 20,000 drawings has numerous dimensions on it, every one of them in the English system, an idea may be formed of the task of translating these drawings that are still alive into the metric system.

In the same issue of the "American Machinist" there is a copy of a single shop order, which was made on tracing cloth by the Bucyrus Co., specifying the different things that go into the manufacture of one elevator. There are listed seventy-three different kinds of articles, and every one of these articles is specified by its dimensions of the English system. For instance,

the first item is a gear with seventy teeth, 2½-inch pitch, 7-inch face, 7-inch bore. Every machinist in America knows exactly what is meant by these items and forms a mental picture of the size and shape of the gear. Translate these dimensions into the metric system and how many mechanics could form a mental conception of the gear until after he had translated the metric measures into English?

TEN YEARS TO GET RID OF THE ERRORS.

In 1895 I published a mechanical engineers' pocketbook of which more than 30,000 copies have been sold. The collection of the material for this pocketbook took more or less of my time for twenty years, and the making of the book not less than three years' full time. The things compiled in it involve references to engineering works, papers and periodicals, some of them dating back at least sixty years. There are 1,100 pages in the book, and each page has about 900 words. The number of figures and formulæ in the book, which are based on the English inch, run into more thousands than I would care to figure. The task of getting such a book free from errors is a tremendous one. Over a thousand typographical and other errors have been reported in the last eight years. Mr. John C. Trautwine, Jr., told me some twenty years after his father's civil engineers' pocketbook was first published that he was only then beginning to feel that the book was reasonably free from errors. If my book were translated into the metric system, it would be at least ten years before all the errors in the translation would be rectified. I doubt if the translation could be made without at least five years' hard labor of an expert mathematician.

I would call attention especially to Appendix IX to the report of the Committee of the American Society of Mechanical Engineers, volume 24, page 691, entitled, "The Metric System: A Big Job for a Literary Engineer." I quote from it as follows:

"The big job, however, would be to produce the literature of the transition period. It would include, in the tables of beams, for instance, all the existing standard sizes, in even inches of depth, with their corresponding metric equivalents to the nearest tenth of a millimeter, together with the dimensions, both English and French, of length, breadth of flange, and thickness of web, the weight per yard and per meter, in

pounds and kilogrammes, and the coefficients for computing strength in both systems. Besides this there would have to be new tables of the new sizes, 20 to 600 millimeters in metric measure and in their English equivalents.

"During the transition period the mechanical articles in the 'Encyclopædia Britannica' and all other encyclopædias and other works of general reference would have to be printed in the transition language, otherwise they would not be readable by the people of the period. When the reform (?) was at last accomplished they would have to be reprinted again, making them altogether metric, and then the old books would all find their way to the paper mill.

"The engineers' pocketbooks would also have to be reprinted in the transition language and then many years later completely metricised. Every present owner of one of these pocketbooks, if the metric system is coming very soon, would have to provide himself with both of the new books, and the transition book would be at least half as large again as the present book and, of course, would sell at a higher price. The first editions also would have so many typographical errors and errors of computation that the new editions would sell rapidly."

I conclude this paper with an extract from Appendix XXI of that report:

"The people of the United States have been born and brought up under the English system. It is a part of their daily life and habit. No power on earth can force the American carpenter to give up his two-foot rule. He will not give it up of his own free will. English measures of length are 'tied irrevocably to the past.' The American people cannot give them up if they would.

"Even if the metric system were far superior to the English system, which it is not, and even if it were possible to enforce it by compulsory legislation, which it is not, the enormous cost of introducing it, the vast trouble and confusion it would cause during the transition period for at least two generations, the abandonment of our mechanical standards, upon which are based the present system of interchangeability of parts of manufactured articles, the making worthless of the greater portion of our technical literature, make the price too great to pay for any advantage, real or supposed, of the metric system."

CXXIV.

TEST OF A HOT AIR HEATING APPARATUS USING RADIATORS INSTEAD OF REGISTERS.

BY GEO. M. AYLESWORTH, M. D., COLLINGWOOD, CANADA.

(Non-member of the Society; Presented by request at Tenth Annual Meeting, New York, 1904.)

In accordance with your invitation I submit the results obtained from the first permanent installation of hot-air radiators during the eight days following its completion.

They were obtained in the city of Collingwood, Canada, which is near the latitude of Portland, Maine, and it is notorious for high winds.

The building selected stood about three-quarters of a mile from the shore of the southeastern end of Georgian Bay.

Georgian Bay is a body of water from 20 to 40 miles wide and 140 miles long from northwest to southeast, over which come the prevailing winds.

The building is a new two-story isolated and brick-clad dwelling practically unprotected from winds, having ten rooms exclusive of closets and halls. The pipes supplying heat to the bath-room and a bedroom over the pantries pass from basement to the first floor through a lath and plaster partition next the kitchen and pantries. As there was no fire in the house, or means of making any, except the furnace, the kitchen and pantry absorbed most of the heat through the partition that was intended for the bath-room and bedroom mentioned, so that the two latter rooms are not included in the temperature record though the heat was constantly turned upon them.

The furnace has a fire-pot 16 inches in diameter and its capacity with registers is estimated at from 7,000 to 12,000 cu. ft. by its manufacturers. The space heated in this test is 13,400 cu. ft. (ground floor 6,450 cu. ft; first floor 6,950 cu.ft.) The outside doors and windows have 415 sq. ft. of which 56 are in the kitchen and pantries, leaving 359 sq. ft. The outside walls have 2,720 sq. ft, of which 480 are around the kitchen and pantries, leaving 2,240 sq. ft.

From these data Professor Carpenter of Cornell University would estimate the radiating surface needed for hot water at 508 sq. ft. Another authority gives 448 sq. ft. which would be an average of 478 sq. ft.

On this test of hot-air radiators there were used 350 sq. ft. of radiation, or 37 per cent. less than the average estimate of these authorities for hot water.

The temperature indoors and the consumption of coal was taken by the writer for the first three days and by a janitor of

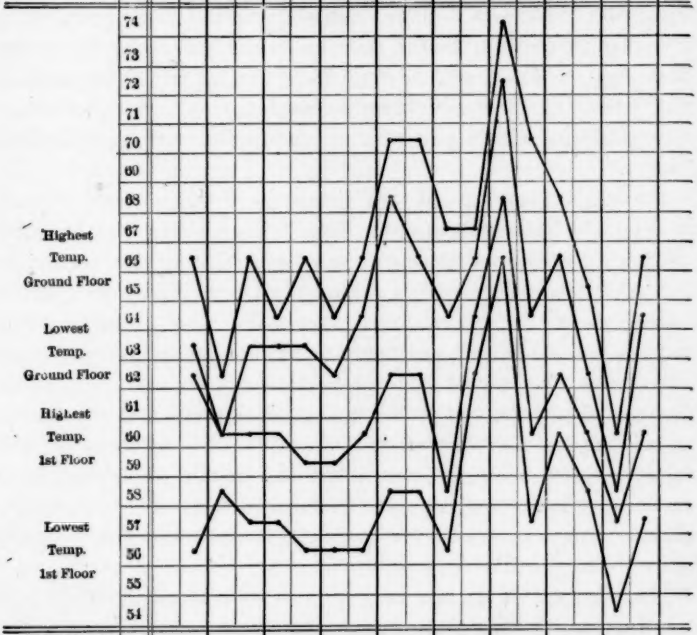
View of Radiator.

experience, but with no knowledge of the furnace used, for the rest of the time.

The temperatures outdoors were obtained from the provincial officer in charge of the meteorological station at Collingwood. In the night of the 27–8, as the test closed on the 26th at 9:30 P.M., the temperature reached −15 with a gale of wind. At 9:30 A.M. of the 28th, with an outdoor temperature of −12, notwithstanding the orders given the janitor not to crowd the furnace on any account after the 26th, the ground floor temperatures were: highest, 60 degrees; lowest, 58 degrees. The first floor: highest, 57 degrees; lowest, 54 degrees. This item is added because −15 is the lowest temperature registered for many years at Collingwood.

The chart gives results for eight days, from 9:30 P.M. of the 18th to 9:30 P.M. of the 26th.

Record
of the first eight days results with the first permanent installation
of
The 20 th Century Radiator



Highest & lowest temp. out doors Meteorological report	28-0	25-4	33-24	34-27	35-11	27-10	35-27	38-19	20-0
	High Winds	High Winds		Doors open good deal with masons setting mantle.	Severe gale of wind all night of 21-2	Blowing gale all night of 26-3. Fire out in morning wind not so high during day.	Gale of wind all night of 22-4. Fire out & furnace cold at 6 A.M. Not much wind during day.	High winds all night of 24-8. Not so much during day, with snow.	Severe gale of wind from the North all night of 2-26. Not much change during day.

A'not of coal burned from 9.30 P.M. of 18th, to 9.30 P.M. of 21st, 153 lbs.
From 9.30 P.M. of 21st to 9.30 P.M. of 26th 350 lbs.

DISCUSSION.

Dr. Aylesworth: I feel that I owe to this Society an apology for the meagre data that I bring before them. The reason for it lies with the Canadian mechanics. The building upon which this system was installed was to have been completed on the first of October, but in reality it was not completed when this test was made, as the painters were still at work on the building. I was therefore unable to get all the data, such as the rate at which the air would travel, and a number of other things about which you will no doubt be putting questions to me.

Professor Kent: I had the pleasure of hearing the Doctor at Niagara Falls last summer, and I am glad he has brought forth this additional paper, and I hope that a year hence he will give us another, giving further light on this subject. What he has shown here is encouraging, and I would like to know more about it. There are many things we might ask questions about, but the Doctor has not yet the figures for them, as he has not made the temperature determinations and the determinations for the flow of air. I would like to know in the future, when he makes his tests, the result of taking daily records, taking, say, ten records daily of the coal consumption and the temperatures. We could then make some estimate of the efficiency of the furnace.

Mr. Barron: This is a very ingenious and novel method of heating, and I think that those who are familiar with furnace work should discuss it. I think this thing is a sheet iron radiator in place of the register with the common hot air furnace, in which the same air circulates over and over, making ventilation prohibitory unless specially provided. There is no cold air box. The only difference between this and the ordinary furnace job is that you dispense with the register, and put in a sheet iron radiator in place of the register. You dispense with the cold air box, and you have a hot air heating arrangement. I should think it is a comparatively cheap way of heating a house by direct radiation. Whether it is better than the ordinary furnace, or whether it burns less coal or not, is of course the problem which the Doctor has set before him, and

I think he has demonstrated partly that it is more economical than the ordinary furnace. But with the ordinary furnace you have a ventilating machine, imperfect, perhaps, but it is a ventilating machine. From what I understand of it, this is not a ventilating machine at all. It is merely a direct heating machine. It is ingenious and novel, and the paper is a very good one to have in our Proceedings.

Dr. Aylesworth: We have here simply the use of hot air in place of water in a closed system. As to its application, it is not intended, of course, to be used in large buildings; it is intended for the heating of medium sized dwellings. As to the question of ventilation, my idea of the matter is that special arrangements for medium sized dwellings are not particularly needed, and not so much needed in this system as they would be in a system of hot air with registers, because the hot air that passes over the furnace in this system does not enter the room and is not respired, whereas in the system with registers the air passes into the room over a heated furnace, which is sometimes overheated, and the result is that the air is not perhaps quite what it should be, although Professor Carpenter, I think, states that the air is not injured by merely passing over the furnace. At least, I heard it stated at the Niagara meeting that it does not injure the air for breathing purposes by passing through an ordinary furnace with registers. Another advantage is that we have no dust, ashes or gases from the furnace where this system is used in place of registers.

Mr. B. H. Carpenter: What is the size of the risers, comparing the ordinary furnace with this style of heating? There would be two risers in place of one, and the question arises whether it would be feasible to get these through the flues, through the partitions, up to the rooms?

Dr. Aylesworth: I would say that all the piping is very much less, that is, the pipes are very much smaller than they would be in ordinary heating with registers. And the piping is figured to have an area equal to the conduit through the radiator.

Mr. Barron: The interesting point here is the proportion of the flow pipe to the return pipe. You can have a much higher velocity in the pipes in this system than in the ordinary furnace system, that is, you can work at as high a temperature as you can get in your furnace. Having that in view, it seems to me

that the two pipes, the flow pipe and the return pipe, can be decidedly less than the one pipe of the ordinary furnace. If I was planning a job on this system to-day I would use pipes only one-fourth of the size, that is, the area of the two pipes would be only equal to one-fourth of the area of the one pipe in the ordinary furnace system. That is a mechanical and commercial advantage. In running through partitions you can make neater and nicer work, and you can make cheaper work. The Doctor's sizes, I think, are exceptionally large. Of course in experimental work it is well to be on the safe side.

Dr. Aylesworth: It has been suggested to me that an elevation of this system was given in the Transactions of the Society in August last. The largest radiator, of four sections, has some 56 square feet of radiating surface, and the pipe leading to it supplying it with hot air is 6 inches in diameter. The amount of radiating surface in this radiator will heat the same as hot water, as near as I have been able to ascertain, although the air enters this radiator at a much higher temperature than is possible with the ordinary hot water system. For that reason I supposed the radiator would give as much heat as steam. But the fact appears to be that the air parts with heat in passing through the radiators so rapidly that it is impossible to keep the whole radiator at the same temperature, and the amount of radiating surface should be figured on the basis of hot water, 56 feet of radiating surface in the radiator requires a 6-inch pipe, and so on down.

Professor Kent: What is the maximum temperature in the radiator?

Dr. Aylesworth: The highest was 213 degrees on entering and 111 degrees, I think, or about that, on leaving.

Mr. B. H. Carpenter: I would like to ask somebody with experience whether or not it would be detrimental to the furnace to keep the heat on the inside and the outside as high as that, whether its life would be equal to the life of the ordinary furnace?

Mr. Joslin: The Doctor made a statement to the effect that a 56-foot radiator ought to require a 6-inch pipe. I would like to ask him if he has tried it on a smaller pipe, 5-inch or 4-inch?

Dr. Aylesworth: No, sir.

Mr. Joslin: So you don't know but what it might work with a 4-inch pipe in the same way?

Dr. Aylesworth: No; but I don't think so.

Mr. Kenrick: I would like to ask if that pipe was 6 inches continuously all the way down, or was there any allowance made for openings?

Dr Aylesworth: It was supposed to be 6 inches in diameter through the course of the circulation. In the partition it was square, but figured to the same area.

Mr. Barron: We have here with us this morning an ex-President of this Society who was notorious for his advocacy of hot air; at least he was at one time; but he has deserted that field and he is now notorious for other things that I hate to mention. I would like to call on Mr. Wolfe to give his views on this subject.

Mr. Wolfe: Mr. President and gentlemen, I can remember when Mr. Barron and I had many a pleasant talk on the subject of warm air furnaces *versus* steam, and so forth. There is no question but what this method is feasible and practical in every way. I agree with Mr. Barron that the flow and the return pipes can be very much smaller. When we flatten down a pipe or square a pipe we lose the corners. The corners are of no use in figuring. You have to strike as near a circle as you can in figuring the volume. Regarding the life of the furnace, if the air enters at 100 degrees, I think it is all right. The great claim we used to make for furnaces as against steam and hot water was that we were not breathing over and over again the vitiated air, but with the fresh air furnace that defect was remedied, a great advantage, particularly in cold countries, such as Canada, where they have tight fitting houses, and where the only supply of fresh air is from the furnace. That is the old argument that we used to use. The steam and hot air men used to say that we would burn the life out of the air. From the best information I can get you cannot burn the oxygen from air unless you subject it to a live flame. What it does do is that it expands the air to such an extent that the moisture, the humidity, is distributed within a so much greater volume that the air is practically dry, and as you breathe it it irritates your nostrils and throat, and what burns is practically what you see in the "sunbeams" that is made up of the filth of the street

and very fine dust drawn through the cold air box that, striking the red-hot fire pot, burns and makes a bad smell. This obviates that difficulty, but it does away with the supply of fresh air in a closely fitted house. As to the size of the pipe, I think he would do exactly as well with a 4-inch pipe as with a 6-inch pipe, because you have a big pump at the bottom—that is all the furnace is. Immediately the air is heated at the furnace it rises in the pipe; and as you reduce the diameter of course your velocity is increased in proportion, though, of course, as you reduce the diameter of the pipes you increase the friction proportionately. But on the whole, I think that about four inches would be within the limit of practice, and that it would be all right.

Mr. Barron: I would like to ask the Doctor if he has thought of using the air under a slight pressure, that is, compressing the air in the system with, for instance, a bicycle pump, and whether, say, an ounce of pressure, or even one-tenth of an ounce pressure, would increase the efficiency of the apparatus?

Dr. Aylesworth: I have not.

Professor Kinealy: Do you run a main pipe through, with distributing pipes branching out at the different levels?

Dr. Aylesworth: The number of radiators to be taken off a single main is determined by the size of the pipe. In this particular installation one main carries four radiators in three rooms and a hall. The last radiator of that main has two sections, or twenty-eight square feet of radiation, and is supplied by 4¼-inch pipe, and is carried up from the cellar to the upper floor in the outside wall, the most exposed portion of the building.

Professor Kinealy: Do you have a single main in the basement from which you run a separate riser for each radiator or do you carry back a riser through the furnace?

Dr. Aylesworth: There is a single main in the cellar. In the event of two rooms being heated on different floors, or three rooms, one main would be carried from that supplying the three radiators.

Mr. Wolfe: There is another gentleman present, Mr. President, who is practically a master in the furnace line, and I would ask Mr. Richardson to give his ideas relative to this subject.

Mr. Richardson: I never have investigated this subject of heating by radiation at all. But there is one reason which I will state why they have to take the air as they do in Canada. I was told in Montreal that it was simply an impossibility to get air to flow into a cold air box with the thermometer 5 degrees below zero in Canada, particularly in Montreal. I know it is the same in Northern Vermont and New Hampshire. So that where furnace heating is used in these extremely cold and dry climates they have to take the air either from the main hall or from the cellar. Regarding this particular system, I never tried any experiments with it, and I am not sufficiently familiar with it to speak on the subject.

The President: Will Mr. Snow discuss this matter?

Mr. Snow: The last remark interested me. I don't quite understand why the low temperature of the air will prevent its flowing into the cold air box. I should think it would flow in all the better. But to return to this system, I wish to ask how the individual regulation is accomplished. Is there one damper on each hot air radiator?

Dr. Aylesworth: Yes, sir; like an ordinary smoke damper.

Mr. Snow: What device is used to prevent overheating of the furnace in case a number of dampers happen to be closed at the same time. With the ordinary hot air system overheating is noticed by the smell from the furnace. An automatic draft regulator is highly desirable on any furnace. They can be put in at a low cost, and act to the furnace the same as a safety valve to the steam boiler. It seems to me that one of these regulators would be a desirable appliance in connection with this system. Experiments have been made with the ordinary hot air heating system, and it has not been difficult to obtain temperatures of 300 degrees or over at the registers, which is about twice, more than twice, modern practice would dictate. I think in modern hot air heating the temperature of the air at the registers, at zero outside, ranges from 120 degrees to 140 or 150 degrees perhaps; and with these higher temperatures it is commonly known, I think, among furnace men that the furnace deteriorates much more rapidly, owing to the fact that there is not a sufficient supply of air passing over the fire pot to take away the surplus heat generated. It is also a well-known fact that the fire pots of furnaces crack, as a

rule, right back of the water pan. If that is located at the front of the furnace, between the feed door and the ash pit door, which is frequently the case, it is likely to happen, because that is the point where the circulation of air is most impeded by the obstruction of the water pan. I think this overheating of furnaces is a point that should be given consideration. A good many people are fearful of hot air furnaces on that account, and I have no doubt that a good many fires have been caused by their overheating. It seems, at first thought, that this system would be more open to that objection than the ordinary method where the air is taken from out of doors and entered through the registers in the usual manner.

Mr. Chew: I will ask if Mr. Snow will provide some time a drawing of the safety device which he suggests in his discussion, so that it can be included in the Proceedings with his remarks on the subject.

Mr. Snow: It is not necessary to make a drawing. I refer particularly to the Rowe regulator. Mr. Kenrick doubtless knows of others in common use in Boston that are quite inexpensive. Some years ago I used one with considerable success, especially in my own house. If one came home late, and the fire was low, if you loaded it up with coal the regulator would do the rest. If the fire came up it would close the check draft and avoid any danger of overheating. Where hand regulation is the rule it is sometimes necessary for a man, after he has left home in the morning, to telephone back that he went away in a hurry and left all the drafts open, and that somebody must attend to them or there will be trouble.

Mr. Berry: I should think there would be certain advantages in this sort of system in some cities, like Pittsburg, where the air is very smoky and bad, and where there is no possibility of taking the air from out of doors at all in through a warm air heater. I don't believe the ordinary furnace fire pot cracks out because of the water pan placed between the ash pit and the feed mouth. I think the circulation of the air in front there is impeded by the ash pit and the feed mouth, and that makes it difficult for the air to circulate. I think the addition of the water pan is a benefit rather than a detriment, as far as cooling is concerned.

Mr. Chew: We used to make furnaces with a water pan in

the corner, and it was not an uncommon thing to get a sash weight and stick one end in the water pan and the other end against the fire pot, and the heat would be conducted into the water and it would evaporate and prevent freezing. In one case we took the water pan and put it in front of the fire pot. Then the air didn't get there, but the heat did. The water did not absorb the heat sufficient to keep the temperature down, and there was more trouble than we had bargained for. It was not long before the front of the fire pot would bulge out, and after the owner found it had cracked he didn't like it. It increased the trade in fire pots materially, but the placing of the water pan at that point increased the destruction of the fire pots to such an extent that the water pan was taken away from there. The ash pit does impede the flow of air in front of the fire pot, and if you put the water pan in there it would prevent any chance for the air to get in at all. There will be an unequal expansion and contraction that will produce a horizontal crack extending across the front of the fire pot, and you can go into almost any furnace man's back yard, if he saves his fire pots to sell for old iron, and you will find sometimes a hole in the front, but more frequently a horizontal crack.

Mr. Eckfeld: I can only confirm Mr. Chew's remark. I had a furnace at home for eight or ten years, and the fire pot is perfectly good around the side, but in front there is a decided fire crack, simply on account of the non-circulation of air, the cold air not getting in there to the same extent as on the sides.

Mr. Snow: I would like to add a word. Many manufacturers, in order to get a pan of large capacity, rest it on top of the opening of the ash pit. The casting comes flush to the top of the ash pit door, and the inner edge of the water pan is made concentric with the fire pot, with the result that the circulation of air is almost entirely cut off there, because this water pan is 14 to 16 inches in width, and offers a very serious obstruction to the passage of air over that portion of the fire pot.

Mr. Wolfe: I would like to ask Mr. Richardson is it not the practice in the better grade of furnaces to-day to make a special frame on the side of the furnace for the water pan?

Mr. Richardson: Yes, sir.

Mr. Wolfe: I think the other method is obsolete.

Mr. Richardson: It is the custom now to make a separate

frame and base for the water pan to set on, around on the side. But so far as I am concerned, I never use a water pan. I don't believe in it in this climate.

Mr. Barron: My conception of this system is that everything that applies to hot water applies to this system; that is, if you consider the relative densities of hot water and of air. You simply use air instead of water for conveying your heat units from the fire. And you can use the overhead system and the single pipe riser system, and any system that is used with hot water. There is not anything that you do with hot water in piping, that has an attic distribution downward or a cellar distribution upward, that you cannot do with this system in the way I conceive of it, and all you have to consider is the relative density of the water you are using, that is, the relative density at the temperature, and the relative density of the air at the temperature; if you keep those things in mind you can base them on the hot water data already established. This discussion is interesting to me for another reason. Furnace heating has never been thoroughly discussed in these meetings. It was better covered in the old works in the heating literature of a hundred years ago than in any recent literature. It is certainly not in our Proceedings. And this is an opportunity to get scientific facts in relation to heating into our Proceedings, on that question, if the right men would only take hold of it.

Dr. Aylesworth: In relation to the remarks of the speaker, who referred to this being an exact counterpart of a system for hot water heating, I will say that it is correct to a certain extent. There is, however, one thing lacking, and that is the necessity of an overflow tank. And another thing I think is impossible, that is, to have a single pipe system; I don't think that is possible.

Mr. Chew: I think the Doctor is entitled to special consideration at the hands of the Society from the fact that he has brought to its attention something absolutely new. I don't remember, in looking back over anything that I have had access to, finding anything regarding the circulation of hot air through radiators; and even if there should be something in the archives that I don't know anything about, the Doctor is entitled to consideration for the courage which he has had to embark in that field and force it on the attention of the public. And I

hope he will have opportunity and patronage enough to secure the application of his ideas, and that eventually we will hear more about it. In view of the fact that he has brought something to our attention that is interesting to furnace men, I think it would not be unfitting to make a motion that he receive a vote of thanks, not only for bringing the system to our attention in the first place, but also for the second time coming with further data. It is not the custom to give a vote of thanks to any member of the Society when he brings a paper that is of special interest; he is simply doing his duty. But when a man in the outside heating world has done something of importance and brings it to the Society by request, I think he has earned our gratitude. I will make a motion that he receive a vote of thanks from this Society for his kindness in exploiting his ideas before us.

Motion seconded and carried unanimously.

CXXV.

TO FIGURE HEATING WORK ACCURATELY—WITH A TABLE SHOWING THE LOSSES IN BRITISH THERMAL UNITS FOR VARIOUS SURFACES.

BY CHARLES F. HAUSS, ANTWERP, BELGIUM

(Member of the Society.)

A safe basis for figuring the losses is the best foundation for a successful heating apparatus, hence, I take great pleasure in presenting to you a table giving in B. T. U. the heat losses through floors, walls, windows, etc., per square foot of surface per hour for various degrees of difference in temperature, based on the best practice of German engineers.

I have endeavored to make the matter all as simple as possible, so that it will be of service to the greatest number.

For the information contained in the table of coefficients (Fig. 1), I am indebted to Mr. Adolf Block of Hamburg, one of Germany's most reliable engineers, who has used it in his daily practice for some years, but of course, in the metric system, with metric calories per square metre in place of the B. T. U. per square foot as shown, hence this table is a collection of facts that should be of more service to the practising engineer than one based entirely on theory.

Following the table are the additions for undue exposure, which means a building poorly constructed, or subject to unusual winds, then the increase for points of compass, after which the increase for greater height of ceiling, and finally, what should be added if there is an interruption in the heating as in the case of halls or churches, that may not be heated every day nor all of the twenty-four hours of the day.

In the second table (Fig. 2), I have endeavored to illustrate how to use the information given in the first table, using the form prescribed by the Prussian law of March 24, 1901, on which all heating work for state and city governments must be figured.

TABLE OF COEFFICIENTS OF TRANSMISSION IN B.T.U. PER SQUARE FOOT OF SURFACE PER HOUR.

Cooling Surfaces	Thickness of Walls	Difference in Temperature—Fahrenheit														
		1°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
Solid Brick Walls.	4½"	0.48	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00	26.50	28.80	31.20	33.60
	10"	0.34	1.70	3.40	5.10	6.40	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.00	23.80
	15"	0.26	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.65	13.00	14.30	15.60	16.90	18.20
	20"	0.22	1.10	2.20	3.30	4.40	5.50	6.60	7.70	8.80	10.00	11.00	12.00	13.20	14.30	15.40
	25"	0.18	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00	9.90	10.80	11.70	12.60
	30"	0.16	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00	8.80	9.60	10.40	11.20
	35"	0.13	0.65	1.30	1.95	2.60	3.25	3.90	4.55	5.20	5.85	6.50	7.15	7.80	8.45	9.10
	40"	0.12	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00	6.60	7.20	7.80	8.40
	45"	0.11	0.55	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50	6.05	6.60	7.15	7.70
For Limestone Walls add 10%	12"	0.45	2.25	4.50	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00	29.25	31.50
	16"	0.39	1.95	3.90	5.85	7.80	9.75	11.70	13.65	15.60	17.95	19.50	21.45	23.40	25.25	29.30
	20"	0.35	1.75	3.50	5.25	7.00	8.75	10.50	12.25	14.00	15.65	17.50	19.25	21.00	22.75	24.50
	24"	0.32	1.60	3.20	4.80	6.40	8.00	9.60	11.20	12.80	14.40	16.00	17.60	19.20	20.80	22.40
	28"	0.29	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05	14.50	15.95	17.40	18.85	20.30
	32"	0.26	1.30	2.60	3.90	5.20	6.50	7 80	9.10	10.20	11.65	13.00	14.30	15.60	16.90	18.20
	36"	0.24	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.40	12.00	13.20	14.40	15.60	16.80
	40"	0.22	1.10	2.20	3.30	4.40	5.50	6.60	7.70	8.80	10.00	11.00	12.00	13.20	14.30	15.40
	44"	0.20	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
	48"	0.19	0.95	1.90	2.85	3.80	4.75	5.70	6.65	7.60	8.55	9.50	10.45	11.40	12.35	13.30
Solid Plaster Partitions.	1¾" - 2¼"	0.60	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00	33.00	36.00	39.00	42.00
	2½". 3¼"	0.48	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00	24.00	28.80	31.20	33.60
Floors	Joists with Double Floors	0.07	0.35	0.70	1.05	1.40	1.75	2.10	2.45	2.80	3.15	3.50	3.85	4.20	4.55	4.90
	Stone Floor on Arches	0.20	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
	Planks laid on earth	0.16	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00	8.80	9.60	10.40	11.20
	" on asphalt	0.20	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
	Arch with air space	0.09	0.45	0.90	1.35	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.95	5.40	5.85	6.30
	Stones laid on earth	0.08	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60
Ceilings	Joists with single floors	0.10	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
	Arches with air space	0.14	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00	7.70	8.40	9.10	9.80
Windows	Single	1.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00
	Double	0.46	2.30	4.60	7.05	9.20	11.50	13.80	16.10	18.40	20.70	23.00	25.30	27.60	30.00	32.20
Skylights	Single	1.06	5.30	10.60	15.90	21.20	26.50	31.80	37.00	42.40	47.70	53.00	58.30	63.60	69.00	74.20
	Double	0.48	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00	26.50	28.80	31.20	33.60
Doors		0.40	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00
Difference in Temperature		1°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°

Add 5% for rooms with unusual exposure.
" 10% where exposures are north, east, northeast, northwest and west.
" 3½% where the height of ceiling is more than 13 feet.
" 6½% " " " " " " " 15 "
" 10% " " " " " " " 18 "

For rooms heated daily, but where heating is interrupted at night, add $A = \frac{0.0025\,(N-1)\,W_1}{Z}$.

For rooms not heated daily add $B = \frac{0.1\,W\,(8-Z)}{Z}$.

In both these formulas :
W_1 = B.T.U. lost per hour by exposed surfaces.
W = Total B.T.U. necessary, including that for ventilation or changes of air.
N = Time from cessation of heating to time of starting fire again—hours.
Z = Time necessary after fire is started until required room temperature is reached—hours.

The little sketch shows an office (corner room) with its adjoining ante-room, their respective temperatures, as well as the temperature of the surrounding rooms, the thickness of walls, location of doors and windows.

To those used to the rule of thumb methods of figuring, this may all seem to be very complicated, and even though some of the columns may not be filled out for every job in regular

practice, the German engineer uses them to keep up his statistics, and can tell how much each job costs per cubic foot or per thousand heat units, and after the tests are made just how much fuel per cubic foot space or per thousand heat units.

It has, however, the advantage of giving accurate results and reducing to a minimum the risks assumed in giving a guarantee.

Column 1, as will be seen, shows the numbers of the rooms; division 2 the name, size, and cubic contents; division 3 the glass, wall and other exposures, in size and square feet, (column "g" in this division showing the "deductions" of windows and doors from the walls); division 4 shows the thickness of walls; division 5, the temperatures; division 6, the coefficients, which are found on the first table (Fig. 1); division 7 shows the heat units lost by cold walls, or gained from warmer walls; division 8 is for the additions due to extreme exposure, interruption in heating and ventilation, and in division 9 we find the totals.

In the two rooms figured it will be noticed that each of the wall and other surfaces is figured separately, so that additions or deductions can be accurately made.

The inner wall on both sides of which the temperatures are the same, as well as the ceiling in which the same is true, would not have to be filled in, in regular practice, but are shown here only for illustration.

As will be seen the corner room loses 14,253 B. T. U. + 1,220 B. T. U. (for north and west exposure) + 4309 B. T. U. for heating the 3,240 cu. ft. of air once each hour,* makes a total of 19,682 B. T. U. that are lost per hour.

Assuming that only one change of air per hour is in contemplation, this room should have, say of two column 38-inch radiation, $\frac{19,682}{275} = 71.5$ sq. ft., or a commercial size of 72 sq.ft.

It is assumed that in a room heated to 70 degrees, one square foot of direct single column radiation gives off 300 B. T. U. per sq. ft.; two column radiation gives off 275 B. T. U. per sq. ft.; three column radiation gives off 250 B. T. U. per sq. ft.;

* As .019 B. T. U. are necessary to heat one cubic foot of air one degree Fahrenheit, to heat 3,240 cubic feet 70 degrees requires 70 × .019 × 3,240 = 4,309 B. T. U. Now, if more than one change of air is required, just so many times 4,309 B. T. U. it would be necessary to add.

Table for figuring the hourly losses of heat.

1	2					3									4	5			6	7			8			9	10
	ROOMS					COOLING SURFACES										TEMPERATURE FAHRENHEIT				B.T.U. WITHOUT ADDITIONS			ADDITIONS FOR			TOTAL B. T. U. INCLUDING ADDITIONS	REMARKS
NO.	a NAME OF ROOM	b LENGTH FEET	c WIDTH FEET	d HEIGHT FEET	e CONTENTS IN CUBIC FEET	a KIND	b POINT OF COMPASS	c LENGTH FEET	d HEIGHT OR WIDTH FEET	e SURFACE SQ. FT.	f NO.	g DEDUCTIONS SQ. FT.	h TOTAL SQ. FT.	THICKNESS OF WALLS INCHES		a OUTSIDE	b INSIDE	c DIFFERENCE	COEFFICIENT OF TRANSMISSION	a LOSSES	b GAINS	c DIFFERENCE	a POINTS OF COMPASS	b BREAK OR INTERRUPTION IN HEATING	c VENTILATION		
1	OFFICE	18	15	12	3240	S.W.	N.	4	7	28	2		56			0	70	70	70.00	3920			392				
	(CORNER ROOM)					S.W.	W.	4	7	28	2		56			0	70	70	70.00	3920			392				
						O.W.	N.	18	12	216	1	56	160	20		0	70	70	15.40	2464			246				
						O.W.	W.	15	12	180	1	56	124	20		0	70	70	15.40	1909			190				
						I.D.		4	8	32	1		32			50	70	20	8.00	256							
						I.W.		18	12	216	1		216	15		50	70	20	5.20	1123							
						I.W.		15	12	180	1	32	148	15		70	70	0									
						FLOOR		18	15	270	1		270			35	70	35	2.45	661							
						CIEL.										70	70	0									
																						14253	1220		420	19682	
2	ANTE ROOM	15	7½	12	1350	S.W.	W.	4	7	28	1		28			0	55	55	55.00	1540			154				
						I.D.		4	8	32	1		32			70	55	15	6.00		159						
						I.D.		4	8	32	1		32			50	55	5	2.00		64						
						O.W.	W.	7½	12	90	1	28	62	20		0	55	55	12.00	744			74				
						I.W.		15	12	180	1	32	148	15		70	55	15	3.90		577						
						I.W.		15	12	180	1		180	4¾		70	55	15	7.20		1290						
						I.W.		7½	12	90	1	32	52	15		50	55	5	1.30	68							
						FLOOR		7½	15	111	1		111			35	55	20	1.40	155							
						CIEL.		7½	15	111	1		111			70	55	15	1.20		133						
																				2507	2223	282	228		578	1088	
	TOTALS				4590																					20770	

Note:- In division 3 column a.
S.W. indicates Single Window.
O.W. indicates Outside Wall.
I.D. indicates Inside Door.
I.W. indicates Inside Wall.
It is assumed that the story under this is a cellar with a temperature of 35° also that the floor above is entirely heated to 70°.
The walls are all of solid brick and plastered.

Charles F. Hauss
Antwerp
November 22, 1903.

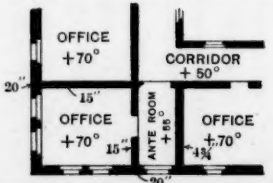


Fig. 2

four column radiation gives off 225 B. T. U. per sq. ft., with a pressure of 1½ pounds at the gauge.

The amount of boiler surface is also derived from the number of heat units necessary in the building. Thus, a round, one-piece fire-pot boiler, having principally direct fire surface, if fired with anthracite coal or coke will supply 4,400 to 5,000 heat units per square foot of fire surface per hour, and if fired with soft coal, from 3,700 to 4,000 heat units per square foot.

A sectional boiler built especially as regards grate, etc., for coke, with principally direct fire surface, supply from 4,000 to 4,200 heat units per square foot—and other sectional boilers fired with bituminous or anthracite coal, from 2,600 to 4,000 heat units per square foot per hour.

Having the total heat units necessary for heating plus that for piping, plus that for ventilation, any job can be accurately figured, and in such a way that there will be an absolute balance between the boiler and radiating surface.

All the foregoing refers to steam heating.

For hot water heating, the number of heat units necessary will of course remain the same, as will the fire surface of the boiler—only the radiation will be increased 60 per cent.

The same number of heat units would also be necessary to heat the same space with hot air, that is, the losses due to colder walls, etc., would be the same, only the losses due to the exhaust or ventilation would have to be considered.

A hot air furnace with considerable extended surface, run at a comparatively low temperature, with easy firing will give off 450 to 550 B. T. U. per square foot of fire surface, whereas one with smooth surface, and not too much flue travel, will give off 750 to 850 B. T. U. per square foot per hour, and the air as it enters the room should be between 100 degrees and 125 degrees Fahrenheit.

DISCUSSION.

The President: The paper is now before you for discussion.

Mr. A M. Feldman: The paper of Mr. Hauss is an interesting contribution to our Proceedings. It is well known that Mr. Alfred R. Wolff contributed some years ago a paper to the Franklin Institute containing a list of coefficients, and he has

also constructed curves graphically representing them. The coefficients are practically similar to those in this paper. I would suggest that Mr. Wolff's chart be appended to this paper. I think Mr. Wolff would not have any objection to that. It has become public property, you might say, as it is contained in the proceedings of the Franklin Institute and in several text-books. I especially commend the second table to the attention of engineers, that being for figuring the hourly losses of heat. I have been using a similar one as a scheme sheet, in which I have three more columns in addition to those given in this table, namely: the amount of radiation to be installed after allowances for local conditions; the ratio of cubic contents per square foot of radiation as a check, and cost per cubic foot. These data I find useful for references. Besides this sheet is so simple that it can be intrusted to a clerk to work out the results, and all you have to do is to check the results.

Professor Kent: Professor Carpenter told me last night that he had looked over the coefficients, and found that they were practically the same as those given by Wolff and by himself in his own books. They may be traced back ultimately to Péclet, and nobody has repeated the work since. All the figures to be got on the transmission of heat to-day are therefore based on a series of experiments made by Péclet over fifty years ago. So Mr. Hauss has not presented anything new in his coefficients. Only the method of arranging them is new. I am glad that Mr. Hauss has not adopted the metric system in this paper. It would be practically unintelligible to the American engineer if he had. I wish Mr. Hauss would let us know if what he calls fire surface is not what we call heating surface. He speaks of direct fire surface and mentions the fire surface of the boiler, but it looks like it was what we call heating surface in this country.

The President: Knowing Mr. Hauss, and knowing where he was educated, I would say that we apply that term to the heating surface of the boiler.

Professor Kent: All the boiler manufacturers in this country say " grate surface " and " heating surface."

The President: He started before the boiler manufacturers did.

Professor Kent: Another thing I wish to call attention to. At the bottom of the fifth page of the paper the author says:

"A hot air furnace with considerable extended surface, run at a comparatively low temperature, with easy firing, will give out 450 to 550 B. T. U. per square foot of fire surface, whereas one with smooth surface, and not too much flue travel, will give out 750 to 850 B. T. U. per square foot per hour, and the air as it enters the room should be between 100 degrees and 125 degrees Fahrenheit." That answers one of the questions raised in the discussion of Dr Aylesworth's paper—how much heat is transferred by a furnace? This is the first time I have seen any such figures in print. I would like to get all the figures of this kind in our records.

Professor Kinealy: Some years ago I made a translation and compilation of the coefficients used in Europe, principally in Germany, and it is published in book form under the name of "Formulas and Tables for Heating Engineers." The coefficients given in this paper are substantially the same as those given in that book. There has been since that time a great deal of work done by others, not only in Germany, but in Italy, and also in England, and Mr. Kent is wrong in saying that no experiments have been made recently. The question of the transfer of heat through metallic surfaces, as in the case of furnaces, has also been investigated to a considerable extent. I have made some experiments, and I find that in the ordinary furnace I can get from 600 to 750 heat units per square foot of heating surface in the furnace. The probabilities are that the difference, or a large part of the difference, is due to the fact that it is extremely difficult to get the heating surface of the furnace. Furthermore, it is extremely difficult to measure the temperature of the hot gases in contact with the heating surface. It is easy enough to get the temperature on the outside, but it is extremely difficult to get the temperature of the gases in contact with the surface on the inside. One word further in regard to the adoption of heating units by the German government. The units were adopted by the State of Prussia, not by the German government. It is exactly the same as saying that the standard for ventilation adopted by the United States government is 30 cubic feet of air per minute per person, when as a matter of fact that is the standard adopted by the State of Massachusetts in the United States. That difference should be borne in mind, for while Prussia is the largest and most important State of the German Federation it is not Germany.

Mr. Snow: It has been stated that a table similar to this one was presented by Mr. A. R. Wolff to the Franklin Institute some years ago. He afterwards amended that table in regard to the loss of heat through windows, and gave the percentage to be added for northerly and westerly exposures. Under the head of windows he has given a loss of 70 heat units per square foot per hour, with a difference of 70 degrees. Mr. Wolff has raised that to 85 in his later practice. And instead of adding 10 per cent., as stated in the footnote on page 2, where the exposures are north and west, he has added 25 per cent. which, personally, I think comes nearer the truth and nearer to what should be allowed in this table and footnote. I believe that it has been the experience of almost all the engineers present that 10 per cent. is altogether too small an allowance to add for a north and west exposure over a south exposure.

Now in regard to the heat given out per square foot of heating surface in a furnace: The greatest amount stated on page 5 is 750 to 850. Many furnaces have about 20 square feet of heating surface to each square foot of grate surface. Assuming the moderate rate of combustion of three pounds of coal per square foot per hour, and assuming further that from each pound of coal 8,000 heat units are utilized, we have 24,000 heat units utilized or transferred to the air passing through the furnace per square foot of grating in the hour. Dividing that by 20, the heating surface, would give about 1,200 heat units given out per square foot of prime heating surface, which personally I believe is more nearly the truth than the lower figures stated. I think they considerably exceed 750 heat units per hour where the surface is prime and well distributed.

Mr. Barron: I believe that if Prussia does anything it is all right, and if Massachusetts does anything it is all right. The convenience of that 30 cubic feet standard is a wonderful thing; it is an approach to a standard, and any formula or scientific principle that is evolved has to be evolved in that way. Some man, or some body of men, or some state or nation, has to say that such a thing is so, just as Mr. Hauss says here that the hot air furnace gives 450 heat units per square foot of fire surface. There is no such thing as absolutely exact knowledge. It all depends on a thousand and one conditions. Nothing is, as I said in my paper, but everything is becoming. All our scientific for-

mulas are changing gradually. The interpretation of them changes day by day, and we cannot give things arbitrarily. These things that are said and done in the German practice have done a great deal of good in the world; they give a man's mind a certain authority to which he can look up. Heat engineering is not yet scientific; steam engineering is hardly scientific in the sense that electrical engineering is. I went a short time ago to the headquarters of the American Institute, and there I saw a young Professor, with his coat off and his sleeves rolled up, lecturing to a class of young men on electricity, and everything was being done in algebraic equations. Each one had a text-book, and the Professor was lecturing on the science of electricity, and was making use of a blackboard, on which he put his equations. Some of the students did not seem to have a very high development, but he was training them in the proper way to learn the mechanical arts at the present time. That is all we have to do; we have to get scientifically exact data, so that a man can refer to something on which he can rely. It will not be absolutely correct; it is arbitrary; the author stands behind it and gives it his authority for the time being. That is what Mr. Hauss has done for this Society, and all that any man does is to contribute his little quota to the advancement of the world and of the work that is being done therein.

Professor Kinealy: I would like to ask for information from any of the members on one other point here. That is in regard to the transfer of heat through furnace surfaces. I think we know approximately for the ordinary furnace; but furnaces have been installed in connection with blowers, and I should like very much to know if there is any member here who has any information as to the amount of heat that will pass through a square foot of furnace surface when a blower is used. I have been up against that problem two or three times, and I have used in my calculations all the way from 1,200 to 2,000.

The President: Is there any gentleman here that can answer Professor Kinealy's question. If Mr. Oldacre is present he can perhaps enlighten Professor Kinealy upon that subject.

Mr. C. E. Oldacre: I have installed a number of blower systems for furnaces for various purposes, for private house work and for church work. I have data which, however, I have not

brought with me, but I can say in general terms that the amount of heat given over from the heating surface is far in excess in the blower system over the gravity system, because the air is carried over the surface faster, and that means that in the same size apparatus a great deal more coal can be burned, and that will give more heat from the same sized furnace. I will say in regard to the heating apparatus at our command to-day that I do not stand in favor of warm air heating or furnace heating with blower systems, for this reason, that some artificial means has got to be used outside of the coal that is burned in the heater to operate the blower, and at the present time the charges that electric light companies make for a current to operate the blower make the cost excessive. If you have to use a steam engine at low or at high pressure you are also burning coal to furnish power to run the blower.

Mr. Barron: I don't want to get away from Professor Kinealy's question. There are gentlemen here that know that when you put a blower on the steam coil you increase the efficiency of the coil a good deal—500 per cent. In other words, I think a square foot of surface at the base of the ordinary aspirating flue, if there is a blower added, is increased in efficiency so that each square foot is equal to five. I may be wrong. I would like to hear from Mr. Snow on that point.

Mr. Snow: For the same reason that the efficiency of the steam heating surface is increased the efficiency of the heating surface in a furnace may be increased by passing more air over it, because more coal may be burned in that furnace, due to the fact that a sufficient volume of air is passing over that surface to carry away the heat which would otherwise injure the furnace. If you attempted to burn the same amount of coal with the natural circulation you would ruin the furnace, but with a blower causing a rapid circulation of air the heat is carried away as fast as it is generated, and the capacity of the furnace and its efficiency is greatly increased. And I agree with what Mr. Barron has said to the effect that a fan applied to the steam coil is easily capable of making that surface give out five times as much heat as it does with the natural circulation. It is not uncommon to figure at least 2,000 heat units to the square foot of prime surface in a blower system with low pressure steam, whereas with our ordinary indirect heating we

don't figure more than one-fourth or one-fifth of that amount. I may add, further, that I am in favor of a good deal of extended surface on furnaces when used in connection with blowers.

Mr. Chew: Mr. Snow's remark is in accordance with the judgment of Mr. George W. Kramer, who has had more to do probably with the introduction of fans in connection with furnaces than most people, and who was the first man to read a paper in our Society on the use of fans with furnaces. I have seen a number of furnaces where Mr. Kramer has specified fans to be used in connection with them. Like all other designers in the field at that time, he did not have as much information as he may have now. He has required that three furnaces be installed in a given building that I know of, and three furnaces would have been necessary to heat it if heated on the gravity plan; but by the use of the fan, I know, from talking with the janitor several months after the building, which is a church, had been built and had been in use, that there never was any occasion, even in zero weather, to light the fire in the third furnace. Two furnaces would do the work that ordinarily would require three. That is another answer to Professor Kinealy. It is not a scientific answer or a direct answer. But it shows that it has been found in practice that two furnaces with the use of a fan would do what three would do according to the gravity plan. Again, Mr. Kramer has endeavored to get several manufacturers to use a special construction that would afford a considerable expanse of surface, and if I understand him correctly, he is in favor of a largely extended surface, much more than is ordinarily provided. In one church that he heated the combustion chamber was circular and 36 inches in diameter. It was about three and a half feet in height, as I remember, and it was made of sectional castings bolted together, and the wings of the perpendicular segments that formed the chamber extended at least six inches. I have seen the cylinder proper at a low red heat, and the outer ends of these would hiss if water touched them, but the red heat did not go out to the end of the extensions. That was a very successful plant, and very satisfactory.

Mr. Barron: I do not think any one would claim that a furnace could be constructed to compete with steam coil for hot

blast work and blower work. Where a blower system was contemplated the early workers in that field struck the right thing, namely, that steam is the only thing to use for blower systems. For the same reason hot water would not be efficient. The furnace would not be efficient commercially; that is my conception of it, and I think that has been found by the experimenters in that field to be correct.

Mr. Joslin: Is it not a fact that the capacity of a furnace that is heating air supplied by a blower is only limited by the amount of coal you can burn? If you burn all the possible coal, you get all the possible heat. If you take a furnace you can probably make it do ten times the amount of work that it does if you resort to forced draft, or taking the air and passing it over the furnace very rapidly, but of course you burn a great deal more coal in doing so.

Mr. Wolfe: The question of extended surface is quite an important factor. I remember a furnace constructed by an exmember of our Society in which he claimed 1,400 feet of surface. The way he obtained it was this: He simply took common sheet iron, wired the edges and fitted up what was practically a horizontal furnace. In point of fact, when he got through with his extended surface the back end of his flue chamber, instead of being a radiating surface, was an absorbing surface; that is, it was at a lower temperature than the air passing over it, and he was giving back to the furnace proper the heat that had been generated at the fire end. This is simply an illustration. It is a grave question in my mind what extended surface is good for in either hot water or steam radiators. Is it any good? Does it condense more steam or not? I don't know.

Mr. Chew: In reference to this extended surface, I will say that there is a furnace manufacturer that I know who constructed his furnaces with wings drawn out six inches from the fire pot, and when a man put in a furnace in his house with this fire pot it lasted a long time. But when at length the man came to buy a new fire pot he was very glad to learn that the same manufacturer provided a fire pot without any extended surface at a very reduced rate, and the confession of the manufacturer is that he never found any great benefit from the extended surface, because the man that bought the fire pot with-

out any extended surface never came back and said: "This does not heat my house."

Professor Kent: I am sorry to see this general lack of information among those gentlemen who have spoken about extended surfaces. It has been well understood a good many years that the extended surface is a good thing when necessary. That is, if you have a regular heating surface, heated to the limit of what it will do, each square foot of extended surface may be worth about half as much as a square foot of prime surface. But if a man has enough without extended surface, and is satisfied, what is the use of adding more surface? It is just as it is in the use of steam boilers. Some people have three times as much surface as they are needing; but if they want more steam out of the boiler they may find that they have not enough heating surface. Hence sometimes an extended surface is found to be of no use because it is not put in requisition.

Mr. Richardson: Cast iron extended surfaces are so much thicker where the fans are used that unequal expansion cracks the pots. The extended surface where it is connected with the fire surface is one thing; where the extended surface is put on in connection with flue surface it is quite a different thing.

Mr. Chew: My experience is different in reference to the wings on the fire pots. They carry the heat out and prevent the overheating of the fire pot—prolong the life of the fire pot. To supplement the remarks I made a moment ago: The trouble with the gentleman who gave me the information was that the man did not come back and say how much coal he burned before and how much coal he burned afterwards. His impression was that there must be much more coal burned when there was not the extended surface to heat the air. I make the motion that this question of extended surface be referred to the Committee on Tests. The reports of the officers have shown that we now for the first time are financially standing with our heads above water. All these questions would long ago have been thrashed out probably, only we could not afford to do it. Possibly the best thing to do now is to move that the question of the relative values of prime and extended surfaces be referred to the Committee on Tests for solution at such time as the Society can afford to pay for the

experiment. They may be able to determine some other method of getting the results without spending money.

Motion seconded.

Mr. Davis: It would seem to me that that is exactly what this Society is for, to establish certain standards that will be adopted not only by this Society, but by societies of engineers and architects. We want to know what is the exact relative value of prime and extended surfaces, and if we go on record to the effect that prime and extended surfaces have certain relative values, they will be adopted by the architects and manufacturers.

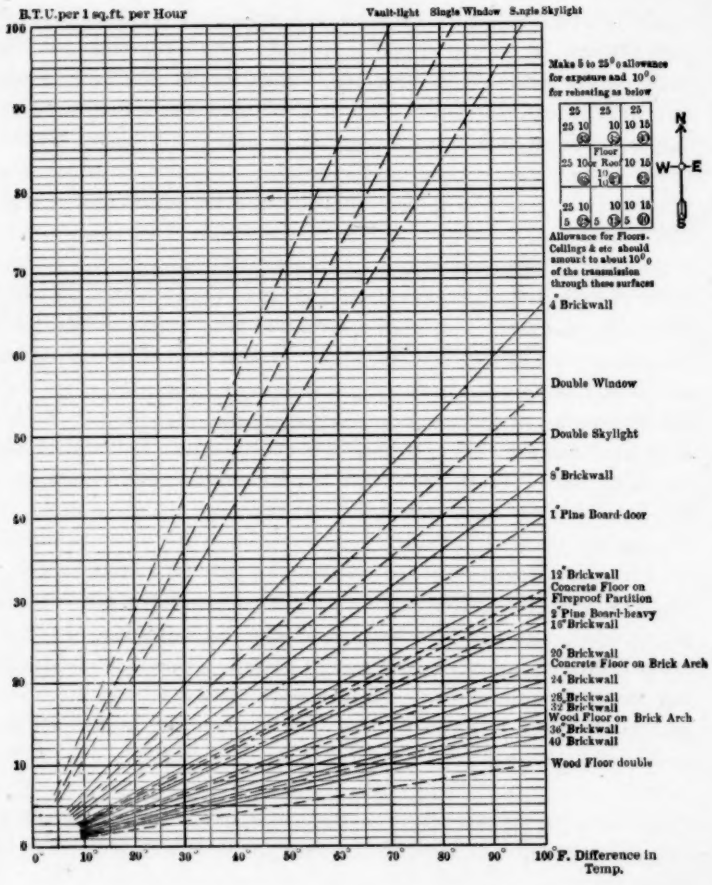
Motion put and carried.

Professor R. C. Carpenter (added since the meeting): I have carefully compared the coefficients for heat transmission presented to the Society by Charles F. Hauss with those given by various other authorities as published in Chapter III of the fourth edition of my work on " Heating and Ventilating Buildings." I find that his coefficients for loss of heat through walls are identical with those given by Recknagel and Rietschel; those for loss of heat through glass are very nearly a mean of the values given by Péclet and by Recknagel and Rietschel. So far as I can ascertain the coefficients given by all these various authorities are computed from the experiments made more than a generation ago by Eugene Péclet, a translation of which is published in my work referred to above. It has also been the subject of discussion in previous meetings of the Society. The extended tables worked out by Mr. Hauss have not, I think, been published before and will, I believe, be useful.

[Added by the Secretary.] Mr. Alfred R. Wolff by request has furnished the following diagram (p. 128) which he uses in his practice:

TRANSMISSION OF HEAT IN BUILDINGS.

A. R. WOLFF.



CXXVI.

THE NECESSITY OF MOISTURE IN HEATED HOUSES.

BY R. C. CARPENTER.

(Member of the Society.)

It is a well-known fact that heated air has a greater capacity to absorb moisture than cool air; thus, as an illustration a cubic foot of air at a temperature of 10 degrees Fahrenheit is capable of absorbing to the point of maximum saturation 1.1 grains of water. If the same quantity of air be heated to a temperature of 70 degrees, it becomes capable of absorbing 7.94 grains, or something more than seven times the former weight of water. It is customary to characterize the relative humidity of air as a percentage of the amount required to saturate it for any given condition and this is determined by scientific calculation based on the difference in temperature between two thermometers in the same room, one of which has its bulb exposed to saturated air and the other to dry air.

It follows from these qualities of air that if cold air, *i. e.*, air at low temperature, be introduced into a room and afterwards heated, that although the total weight of moisture may remain unchanged its capacity for absorbing moisture will be very largely increased and its relative humidity will be very greatly diminished. It is established, I think, with reasonable certainty, although there seem to be very few experimental data available on the subject, that the inmates of a room are more comfortable when the relative humidity of the inside air does not differ greatly from that to which they are accustomed outside. This is probably due to the fact that the evaporating capacity of air increases as the relative humidity diminishes, and this is of such a nature as to absorb any free moisture from the body; this causes the skin to become dry, and the body feverish. It is likely to cause unpleasant sensations such as itching and pricking. The process of evaporation is also a cooling one and its effect is to draw heat from the human body

somewhat in proportion to its rapidity; this tends to lower the temperature of the body and by so doing causes a demand for a higher temperature in the room than would have been required had the relative humidity remained unchanged.

The amount of moisture required to maintain the relative humidity the same as the outside air may be of considerable amount. Thus, supposing saturated air at 10 degrees Fahrenheit be introduced into a room at the rate of 1,000 cubic feet per hour, we find by consulting tables that in order to maintain the air at the saturated condition we shall need to introduce, if the air be warmed to 70 degrees, about 6.8 grains of water for each cubic foot, or for the 1,000 cubic feet we would need 6,800 grains, or practically one pound per hour. It however is probably never desirable to maintain the air at a condition of absolute saturation, but it is generally thought to be desirable to maintain its relative humidity at a point approximating 50 per cent. (Mr. Loveland puts the limit at 30 per cent.) of saturation, or within 10 to 15 points of the ordinary relative humidity of the outside air. If this condition were produced, about 50 per cent. as much water would be needed as indicated in the previous calculation, namely about one-half pound of water per 1,000 cubic feet of air per hour. A building requiring 10,000 cubic feet of space would, by this calculation, need to have something like 5 pounds of water or say 2½ quarts evaporated per hour in order to maintain the degree of humidity somewhat near that usually found in the outside air. This calculation is interesting as showing that large amounts of water may be needed to preserve the relative humidity the same as that of the outside air during the processes of heating.

I am of the opinion that popularly the hot-air furnace is credited with removing more moisture from the air which it warms than is the case with the steam or hot-water radiator. From the effects, however, which I have frequently observed as to the drying out of furniture and the shrinkage of woodwork generally, I am inclined to believe that this opinion is somewhat in error, and I think that accurate measurements will fail to prove the hot-air furnace to be a greater sinner in this respect than our other systems of heating. The hot-air furnace is usually provided with a water pan so located that an opportunity is presented for the air to absorb moisture; but the ex-

perience with the pan, as usually constructed, has in most cases proved that it was entirely inadequate to accomplish any useful result. It is very seldom that any attempt is made in the case of steam or hot water heating to supply the necessary moisture required to keep the air at a uniform degree of humidity, although it may often be necessary.

I think there can be no doubt but that the human body requires, in order to be comfortable, a higher temperature if the relative humidity of the air is low than if it approximates the humidity of the ordinary outside air, and that consequently we should find that means for increasing the amount of moisture in a room up to the proper degree of saturation would enable us to be comfortable at a lower temperature and thus economize in our fuel requirement.

It would be an interesting question to know what effect the dry air in our inhabited rooms has upon the health of the occupants. I think we will find much difference of opinion regarding this proposition. It is a well-known fact that dry air is extremely favorable for the cure of certain diseases and I believe, also, that it is quite certain that it is not quite so favorable a medium for the propagation of disease bacteria as moist air, but nevertheless I do not think it as healthy for a normal person; but regarding this I have few data which could be considered as conclusive.

Mr. G. A. Loveland, section director of the United States Weather Bureau, Lincoln, Neb., read a paper on this subject before the Nebraska Academy of Sciences, January 25, 1902, which I think should find a place in our Proceedings and as presenting some valuable observations I have quoted it entire in this article, which is written principally in the hopes that it will call out a discussion and in this manner bring together valuable facts and experiences.

"The previously evident effect of dry air on the furniture in the United States Weather Bureau office in Lincoln, Neb., during the winter months resulted in the taking of a few observations to determine the relative humidity of the air in the rooms in the winter of 1898–99. The relative humidity proved to be so low that it was decided to make a consecutive record for the next winter, that of 1899–1900. Mr. A. B. Smith, a student in the university, working in the office, becoming inter-

ested, kept the record. Observations were made usually twice a day, but sometimes as many as four or five times a day, and occasionally but once a day. The observations were made by means of an ordinary sling psychrometer.*

"The rooms are heated by steam, using the ordinary pipe radiators. Lack of time prevented Mr. Smith's computing the relative humidity from the mass of observations for the use he intended to make of them. When he graduated in June, 1901, he transferred his data to me in the hope that they might prove useful. During the summer and early fall these observations were computed and tabulated for convenient study by my wife and myself. The result proved that the air in the office was exceedingly dry during the whole winter. The coldest month, February, 1900, with a mean temperature in the shelter of 19.2 degrees above zero, was also the driest in the office, with an average relative humidity of but 15.3 per cent. The variation was not great from day to day, the extreme ranges for February, 1900, being from 7 to 25 per cent.; but the record shows that it was only twice above 20 per cent. and once below 10 per cent. December, 1899, comes next, with a mean exterior air temperature of 22.6 degrees and a relative humidity in the office of 18.6 per cent. January, 1900, was warmest and in the office the most moist, with a mean temperature of 26.8 per cent. outside, a relative humidity of 21.0 degrees inside. The temperature of the office did not vary materially for the three months, and averaged slightly below 70 degrees. The relative humidity, from the readings of the whirled psychrometer in the shelter, was: For December, 77.4; for January, 73.4, and for February, 77.9 per cent. This gives a mean relative humidity of the outside air for the three months of 76.2 per cent., while for the inside air for the same period it was but 18.3 per cent. In an article in the "Boston Medical and Surgical Journal" of March 1, 1900, Mr. R. DeC. Ward, Instructor in Climatology in Harvard University, gives the relative humidity of the outside air at many of the driest places where observations have been kept, including places near the deserts in both Asia and Africa, but he quotes no place as dry as the Weather Bureau office at Lincoln was during the three months mentioned.

* Described in pamphlet issued by the Government Weather Bureau.

"The results obtained as above stated caused me to attempt an experiment this winter. I live in the north half of a double house. The two halves are very much alike, of course being built under exactly the same conditions, and heated by the same sized furnaces of the same make and pattern. The arrangement of rooms is slightly different, but the cubic space of each house is about the same—14,000 cu. ft. Furnaces are almost invariably furnished with a pan in which water may be kept, since, as text-books say, "heated air requires more moisture than cold air contains to maintain a comfortable degree of saturation."

"The investigation began by using the water pan in my furnace and not using the one in my neighbor's house, and by making humidity observations to determine the efficiency of the pan as an attachment to a furnace. The water pan holds 20 quarts. The amount of water evaporated from the pan was determined each day by filling it daily and measuring the water required. The observations commenced November 4, and were taken once daily by my wife about 12.00 noon. The result of the first 17 days' observations was as follows:

	Average Temperature of air.	Average Relative humidity.
Inside, with water pan	72.1°F.	36.2%
Inside, without water pan	67.9°F.	38.8%
Outside	39.4°F.	68.2%

"The amount of water evaporated was two quarts per day. The difference in humidity seems to be due almost entirely to the fact that one house was, on the average, warmer than the other. Reduced to a temperature of 70 degrees, there seemed to be a slight difference—about 1 per cent.—in favor of the house with the water pan, but the difference was so very slight that the value of a water pan as an adjunct to a furnace was not established, but on the contrary it seems probable that such a small pan is of little or no value.

"It was then determined to increase the evaporation sufficiently to affect the humidity, continuing to measure the water. Pans of water were placed in each of four registers. This increased the evaporation to an average of 5.9 quarts per day for the 17 days beginning November 23. The averages for this period were as follows:

	Average	
	Temperature of air.	Relative humidity.
Inside, with water pan	70.0°F.	35.8%
Inside, without water pan	70.0°F.	33.4%
Outside	39.3°F.	73.8%

"For this period the temperatures in the house averaged the same and the relative humidity was 2.4 per cent. greater in the house using water in the furnace and register pans.

"Two large pans were now attached to the furnace at the point where the cold-air return delivers the air to the furnace to be reheated. These were in operation for the period from January 15 to January 21, and increased the evaporation to 10 quarts per day for the period, with the following results:

	Average	
	Temperature of air.	Relative humidity.
Inside, with water pan	69.9°F.	29.1%
Inside, without water pan	70.0°F.	26.9%
Outside	33.3°F.	66.8%

"This shows a difference of 2.2 per cent. in favor of the house in which the 10 quarts of water were evaporated daily, from which it would seem that the 4.1 quarts increase in water evaporated did not quite offset the lower temperature (averaging 6 degrees) and lower humidity (averaging 7 per cent.) of the outside air in the second experiment.

"The only ventilation the houses have is one open fireplace in each. No special effort was made to change the air other than that resulting from the ordinary usage of dwelling-houses. As the two houses were so nearly identical in all conditions affecting ventilation, it was assumed that the change in air was practically the same in both houses. Neither furnace took air directly from outdoors; the cold-air return from the rooms and air from the cellar were the only sources of air for the furnaces. If there was no change in the air, six quarts of water would be sufficient to saturate the air in one house. It seems probable, however, that the air in a house of this kind, with no special effort at ventilation, changes completely once in two hours, and possibly once an hour, or even in less time. With this in mind, it will be seen that in a house of the kind in which these experiments were made (ordinary 8-room) 70 to 150 quarts of water, or possibly more, per day, will be required to maintain the relative humidity as high as it is outside the house, the difference between inside and outside temperatures being from

35 degrees to 50 degrees, as is the case in winter months in Nebraska. This degree of humidity would not be desirable, for the moisture in the house would condense on the windows to such an extent as to be very disagreeable. In fact, later in the winter, with a daily evaporation of 36 quarts and a temperature slightly above zero outside, 70 degrees inside, and an inside relative humidity of 30 per cent. (about 10 per cent. higher than in a house without evaporation), considerable condensation on the windows took place, but not sufficient to be troublesome.

"At present, from a rather short series of observations in a house heated by hot water, but quite extensive observations in furnace and steam heated rooms, there seems to be little or no difference, so far as the relative humidity of the air is concerned.

"I do not know what effect the dry air of living and office rooms has upon health, being unable to find a record of any experiments in this direction. Most physicians maintain that it is injurious, but this seems to be based mainly upon theoretical considerations."

It should be noted that very frequently the air in the houses is not over 12 to 15 per cent. saturated, and in this respect the dryness experienced is greater than in most of our deserts.

The question has already excited considerable interest and Mr. M. N. Baker, editor of "Engineering Literature," in his issue of December 10, 1903, has discussed the question at length and quoted the opinion of a number of authorities, but has not been able to find any decisive experiments.

Mr. W. W. Johnson, of Milwaukee, has invented an instrument which he terms "the humidostat" which automatically supplies the necessary moisture for maintaining a constant degree of humidity. I have had no practical experience with this instrument. In the circular issued by the Johnson Service Company, who are putting this instrument on the market, we find the following statements are made regarding the effect of dry air:

"Medical authorities tell us that the physiological symptoms of an atmosphere too dry are parched lips and tongue, a dry, feverish condition of the skin and in those children predestined to lung diseases, a hacking cough, resulting from the desicca-

ting effect of excessively dry air on the lungs and bronchial tubes."

"A mummified and shrivelled appearance of the human skin is caused by a dry atmosphere."

"Baldness and the breaking and splitting of hair are frequently due to the same cause."

"If the air moisture is adequate you will be comfortable in a temperature of 5 degress less than in a dry air. This it has been estimated will make a fuel saving of from 12½ to 15 per cent." Unfortunately, the authorities who are quoted are not given in the pamphlet issued by the Johnson Service Company.

Mr. W. W. Macon, editor of the "Engineering Record," has given a description of an apparatus for automatically supplying water which was designed by Mr. Wolff for the Carnegie residence.

Believing that this question is of importance and that it will be of interest to the Society, and if settled that it will be the means of improving our practice in the art of heating and ventilating, is the excuse which I offer for inflicting on it a paper of this character.

CXXVII.

THE BATTERY SYSTEM OF WARM AIR HEATING.

DESCRIPTION OF THE INSTALLATION OF THE SAME IN A COUNTRY OR SUBURBAN HOUSE.

BY C. E. OLDACRE, PHILADELPHIA, PA.

(Member of the Society.)

That little or no dependence can be placed in a large majority of the heaters now in use has been fully demonstrated. It goes without contradiction that not less than fifteen out of every twenty of our homes are imperfectly heated. This is not as it should be, nor is there any reason for its being so. Proper apparatus, installed by competent engineers, can correct these defects. The poor results obtained is not the only question to be thought of; it is the uneconomical method of producing these results as well—wastefulness of fuel.

Failures are not only due to inherent defects of the apparatus itself but due very largely to faulty work in the construction—faulty construction work due to a lack of knowledge of the business; due to inattention to necessary detail; due to omission of important factors; due to a feeling that anything, no matter how poor, was good enough so long as it was out of sight; due to too much "rule of the thumb" work; and last, but not least, the mistake of taking work at less than cost, and finding it out only when the work is begun, causing a curtailing of many necessary features.

Of course, many failures that occur with heating apparatus are due to lack of management or improper care. In many cases, in fact, it is almost expected they will do the work required of their own accord, with little or no attention.

Necessarily, any heating apparatus should be as simple as is compatible with the work in hand, and simplicity is one thing to which warm air heating can freely lay claim.

With warm air heating there is no danger of radiators or piping bursting, with consequent damages; no danger from freezing of water in boiler or radiators if house should be unoccupied for a time during cold weather. There is no danger of freezing of radiators or piping, as there is with indirect steam or hot water if the fire is allowed to get quite low or if the circulation may be very sluggish at some points. In case of repair, due to accidents or natural wear and tear, they are not as expensive for any renewal of parts that may be required.

In a direct system of steam or hot water heating, the sole reason for the radiators and piping is the idea of obtaining heat therefrom; for, surely, they are no ornament to a room at their best, besides taking up space which would otherwise be used for furnishings. Any one who has ever had the experience of having a steam or hot water heating plant installed in his house can fully appreciate this point, and has noticed that there has been quite a conflict of ideas between himself and the contractor as to the exact location of the required radiators and piping, they coming seemingly at the very points that were allotted to other uses, or else coming at most inconvenient or unseemly locations in the various rooms.

With a well-constructed warm air heating system, in addition to the avoidance of the unsightly radiaors and piping, and saving the space they occupy, the advantage of ventilation is obtained, as pure, fresh, warm air is constantly being forced in, displacing the colder air.

Many heaters have been well and properly placed, yet failed to do the work they should, for the reason that the amount of heating surface was deficient.

It was mainly with the idea of getting a larger amount of heating surface, without unduly increasing the grate surface, that the writer came to the idea and use of the Battery Warm Air System. Essentially, it is the setting of two or more heaters side by side, cased up separately to the top of the castings and connected together at the top by one common hood or air chamber, from which the various pipes are led to the various rooms to be heated.

Fig. 1 gives a general idea of this mode of construction.

Taking a certain type of heater, with a grate 30 inches in diameter, that has 150 square feet of heating surface, one of

the same type, with a 21-inch grate, has 100 square feet of heating surface, or 33 1-3 per cent. more surface than the one heater having a grate 30 inches in diameter.

The 30-inch heater has 707 square inches of grate area, and the two 21-inch heaters combined would have 692 square inches, or a trifle less grate surface than the one heater having a grate 30 inches in diameter.

Allowing that the grate surface in both cases is very nearly the same, and that there is approximately 5 square feet of grate surface in both cases, then, with heater having a grate 30 inches

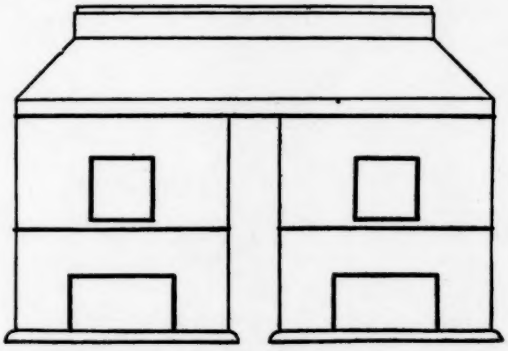


FIG. I.

in diameter, there is a relation of grate surface to heating surface of 1 to 30, and with heater having a grate 21 inches in diameter, there is a relation of 1 to 40.

As illustrative of the application of the Battery System of Warm Air Heating, the floor plans of a three-story suburban house are here given, together with a layout of the heating work as it was carried out in the building.

The house is located at Jenkintown, Pa., which is near Philadelphia; stands exposed on all sides and is unprotected by other buildings or trees, and is situated on high ground, having the front facing to the north. It is constructed partly of stone and partly of framework.

The plant has been in operation through weather when the thermometer has registered as low as 12 degrees below zero, Fahrenheit, and has been unqualifiedly satisfactory to the owner.

The total cubic contents of all the rooms to which heat is carried is 33,744 cubic feet.

The total square feet of exposed wall surface is 2,853.

The total square feet of glass surface is 731.

The total square feet of equivalent glass surface is 1,537.

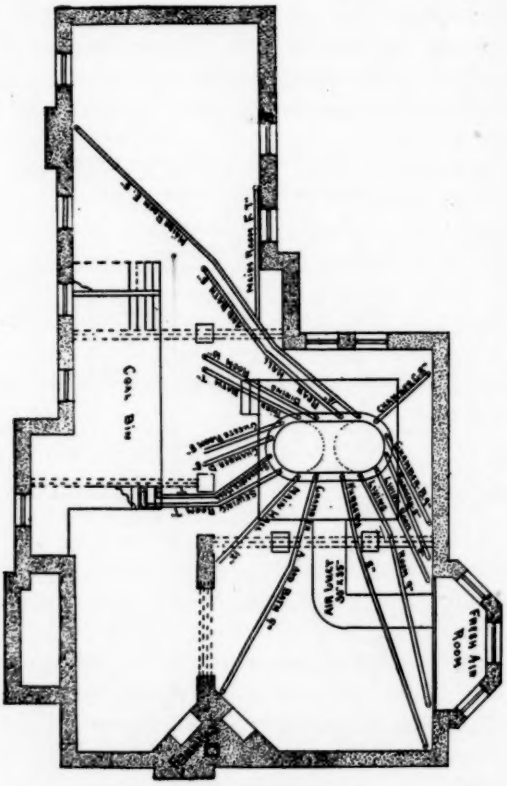


FIG. 2.—CELLAR PLAN.

The heaters are located, as shown on the cellar plan in Fig. 2, in the west central part of the cellar.

The cellar is excavated at this point to a depth of 8 feet 6 inches clear of the first floor joist, which permits ample pitch to all pipes.

The heaters have grates 21 inches in diameter, and the total heating surface of the two heaters is 300 square feet, or 150

square feet of heating surface in each heater. The total grate surface being about 5 square feet; this gives a relation of grate surface to heating surface of 1 to 60.

The heaters are set 12 inches apart, and are connected together to a common dome, or air chamber that allows 18

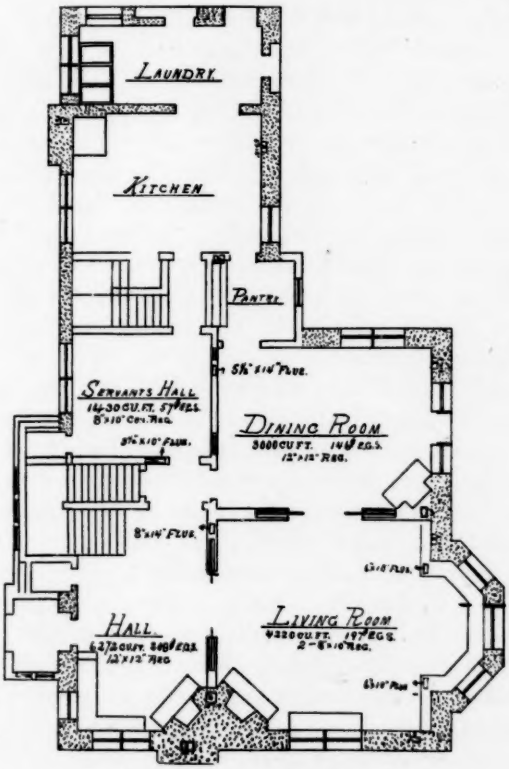


FIG. 3.—FIRST FLOOR PLAN.

inches clear space between its top and the top of the castings. From each heater there are 8-inch smoke pipes, which are connected directly to one 10-inch galvanized iron smoke pipe that leads to the chimney. The chimney is 9 x 13 inches, and has a terra-cotta lining that measures 7½ x 11 inches on the inside. The location of the chimney is not the most desirable, as it necessitates a longer smoke pipe than should be the case. The

chimney stack was located at this point in carrying out the architectural features of the house, and was the nearest that could be had.

The fresh air is brought in through three windows on the west side of the house. The net area of these windows is about 1,000 square inches.

The air passes through these window openings into the fresh air chamber, which was constructed by tightly boarding off that part of the cellar directly under the bay window of the living room, on the first floor. The fresh air is carried from this fresh air chamber to the heaters through a galvanized iron duct that is 30 x 35 inches. Near to the heaters this duct is divided into two parts, giving one-half its area to each heater. The air is taken into the heater through ducts made of galvanized iron that are equal in width to the diameter of the heater casing or outside jacket; that is, these leading-in ducts, which are above ground, are each 14 x 51 inches, which allows of an even distribution of air to all parts of the heater.

Near the fresh air chamber there is located a cut-off damper, which is so arranged that when, from the indicator on the outside, it shows that the damper is shut, it still admits of an opening of two-fifths of the size of the main duct; that is, when the indicator shows that the damper is shut, it closes off three-fifths of the area of the duct.

This arrangement permits cutting down too great an inrush of air during high winds, and also at night, when the fires may become low. This arrangement also prevents the duct from being entirely closed off at any time, as in such case there is a likelihood of damage to the heater and a serious disarrangement of the working of the heater during such time, if such total closing off of the air supply were possible.

In each half of the duct leading to each heater there is placed a tight damper; also in individual smoke pipes there are tight dampers. The tight dampers of each duct and smoke pipe of the heater to which such duct leads are so connected together by chains that when the chain is operated to close the duct to any one heater it simultaneously closes the damper in the smoke pipe. Should such chain break or become detached, then they are so arranged that both dampers will automatically open, thus avoiding any dangers from closing the smoke pipe or air duct.

The purpose of these dampers is to allow of the use of either one of the heaters separately, at any time, if so desired.

If the air was permitted to enter through one of the heaters which had no fire in it, then this air would greatly reduce the temperature of air that was coming into the warm air chamber from the heater that was in operation. Also, if it were possible to close off the air duct to one heater without at the same time closing its smoke pipe, then it would be possible, through neglecting to see that the air valve was opened again, to build a fire in this heater and thereby possibly cause damage to the heater. Also, by closing the smoke pipe to the heater that may be out of operation, a better draft is afforded to the heater that may be in operation.

The heater casings are galvanized iron, lined on the inside with corrugated asbestos. The top or dome is of the same material, and is lined with currugated asbestos and an inner lining of tin plate.

There are 16 collars or outlets on the heater top for the connection of the heat pipes. Nearly all of the pipes are connected to separate rooms. The collars are made flaring; that is, the bottom of the collar connecting to the top of heater is made 2 inches larger in diameter than the top of the collar to which the pipe is attached. The purpose of this is to afford an easy flow to the air and prevent too great friction at this point, as would be the case with a perfectly square or right-angled connection.

All of the pipes are made of IX bright tin plate, AAAA grade, 270 pounds to the box, and are covered with corrugated asbestos, secured to the pipes by means of japanned metal bands. Wherever there is a change in shape or direction of the line there are placed easy bends or transition pieces, which afford the least friction possible.

All of the flues in the partitions and walls, made of the same material as the heat pipes in the cellar, are covered with asbestos sheathing paper; those in partitions with two thicknesses and those in outside wall have two thicknesses around the pipes, and then there are four thicknesses of the same material between the pipe and the wall in addition, the purpose of the asbestos paper being to prevent radiation from the pipes and to permit of as little loss of heat from the heater to the outlet as possible.

Over all the heat flues there is punched metal lathing, on which the plastering is done.

Each outlet is supplied with a plain lattice register. Where the depth of the register box is such that a plain-faced register would cut off a part of the area of the flue, a convex-faced register is used.

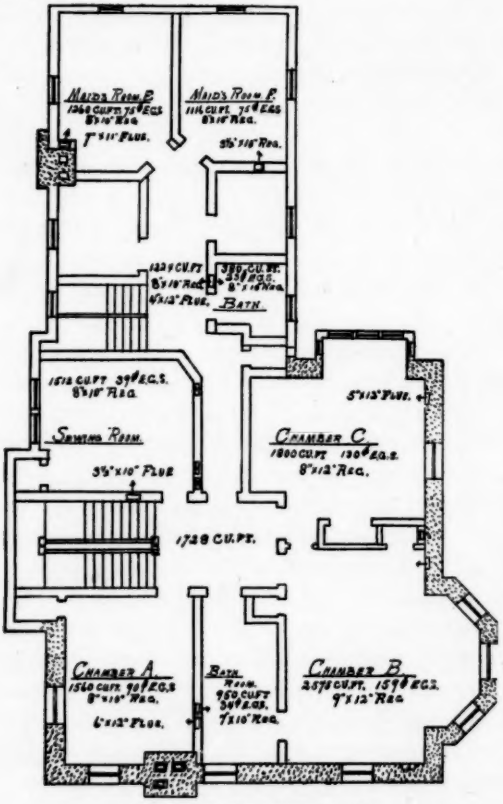


FIG. 4.—THIRD FLOOR PLAN.

The total area of all the heat pipes is 983 square inches, which area is distributed among 16 different pipes.

The total area of the space heated is 33,744 cubic feet.

The total wall surface, less the glass surface, is 2,853 square feet.

The total glass surface is 731 square feet.

The total equivalent glass surface is 1,537 square feet. In this computation 4 square feet of wall surface are reckoned as equal to 1 square foot of glass surface, and for the third-story rooms 10 square feet of the ceiling are calculated as having the same cooling effect as 1 square foot of glass surface.

From the above figures it will be seen that there are 34.3 cubic feet of air space for each square inch of area in the heat pipes, or that there is an area of 29 square inches in the heat pipes for each 1,000 cubic feet of air space.

TABLE I.

		Cubic feet Contents	Sq. feet wall sur. (net)	Sq. feet glass sur.	Sq. feet equivalent glass sur.	Area heat pipes sq. in.	Proportion of heat pipe area to space heated sq.in. cu.ft.	Proportion of heat pipe area to equivalent glass surface sq.in. sq.ft.
Living room	19' x 20' x 10'	4,220	378	102	197	126	1 to 33	1 to 1.56
Dining room	15' x 20' x 10'	3,000	216	84	146	78	1 to 38	1 to 1.87
Main hall—								
First floor	12' x 24' x 10'	2,880	306	114	190	113	1 to 55	1 to 1.84
Second floor	8' x 24' x 9'	1,728	72	...	18	...	.....	.....
Third floor	.....	1,664	...	...	...	...	.....	.....
Servants' hall	11' x 13' x 10'	1,430	44	30	57	38	1 to 38	1 to 1.5
Chamber A	11'6" x 15' x 9'	1,557	240	30	90	42	1 to 37	1 to 2.14
Front bath	7' x 15' x 9'	945	48	24	34	21	1 to 45	1 to 1.6
Chamber B	19'6" x 12'6" x 9'	2,574	368	63	159	63	1 to 41	1 to 2.5
Chamber C	16' x 12'6" x 9'	1,800	234	72	130	50	1 to 36	1 to 2.6
Sewing room	12' x 14' x 9'	1,512	96	25	30	50	1 to 30	1 to .78
Rear bath	6'6" x 6'6" x 9'	378	53	10	23	20	1 to 19	1 to 1.15
Maids' room F.	9'6" x 13' x 9'	1,116	200	25	75	63	1 to 18	1 to 1.2
Maids' room E.	10' x 14' x 9'	1,260	200	25	75	63	1 to 20	1 to 1.2
Rear hall	.....	1,224	...	...	...	30	1 to 40	.....
Nursery	16' x 20' x 8'	3,712	316	60	159*	100	1 to 37	1 to 1.6
Chamber D	13'6" x 13' x 8'	1,208	30	30	68*	50	1 to 24	1 to 1.36
Guest Room	12' x 12' x 8'	1,152	64	24	55*	38	1 to 30	1 to 1.45
Bath	6' x 8' x 8'	384	36	8	22*	38	1 to 10	1 to .6
Total	.....	33,744	2,853	731	1,537	983		

*There is added at a ratio of 1 to 10 for ceiling of third floor the following E. G. S.: Nursery, 51 square feet; chamber D, 37 square feet; guest room, 15 square feet; bath room, 5 square feet.

There are 1.56 square feet of equivalent glass surface for each square inch area in the heat pipes. There are also approximately 4 square feet of gross exposed wall surface for each square inch area in the heat pipes.

For the purpose of comparison of the various proportions and dimensions, the following tables have been prepared, showing the dimensions of the rooms, the space heated, the wall, glass and equivalent glass surface, the diameter and area of the heat pipes, the size of the registers and the proportion of the heat pipes to the space heated and the relation of the heat pipes to the equivalent glass surface (E. G. S.):

Also a general resume, showing these and further data, is given in Table II.

TABLE II.

Grate Surface	Diam. A. 2. 21 in. 692
Heating Surface	300 sq. ft.
Type of Furnace	Cast iron. Indirect draft.
Space Heated	33,744 cu. ft.
Outside Dimensions and Character of Building	3 story stone and frame Ceilings, 16, 9 and 8
Wall Surface	3,584 sq. ft.
Glass Surface	731 sq. ft.
Equivalent Glass Surface. The E. G. S. equals the glass surface plus one-quarter of the difference between the wall surface and the glass surface	1,537 sq. feet
Number and Size of Hot Air Pipes	3. 7 inches 5. 8 inches 5. 9 inches 1. 10 inches 2. 12 inches
Area of Hot Air Pipes	983 sq. in.
Size and Area of Cold Air Supply	30 in. × 35 in. = 700 sq. in.
Proportion of Hot Air Pipe Area to Space Heated	Sq. in. to cu. ft. 1—34.3
Proportion of Hot Air Pipe Area to Equivalent Glass Surface	Sq. in. to sq. ft. 1—1.56
Proportion of Grate Area to Space Heated	Sq. in to cu. ft. 1—47
Proportion of Grate Area to Equivalent Glass Surface	Sq. in. to sq. ft. 1—2.2
Proportion of Grate Area to Heating Surface	Sq. ft. to sq. ft. 1—61
Proportion of Heating Surface to Space Heated	Sq. ft. to cu. ft. 1—112
Proportion of Heating Surface to Equivalent Glass Surface.	Sq. ft. to sq. ft. 1—5

It will be noticed that there is a wide variation in the relation of the area of heat pipes to the cubic contents, and also to the equivalent glass surface (E. G. S.), but this variation has been occasioned by the conditions and necessities of the case. Exposure, direction of exposure, elevation and length of the heat pipes, the surroundings of the heat flue, the friction due to bends in the heat flues caused by the building construction, and the relative size of the heat pipes, are factors that were considered in the designing of this plan.

As an illustration of the distribution of the heat, the following result of an examination of the house, with the plant in operation, may be of interest:

	Temperature of Room.	Temp. of Air at Reg.
Hall	80	180
Living room	80	172
Dining room	79	170
Servants' hall	79	174
Chamber A	76	146
Front bath	79	146
Chamber B	78	180
Chamber C	80	180
Sewing room	80	156
Rear bath	84	150
Maids' room F	76	130
Maids' room E	75	120
Rear hall	80	150
Nursery	83	178 and 142
Chamber D	78	134
Guest room	79	146
Bath	77	145

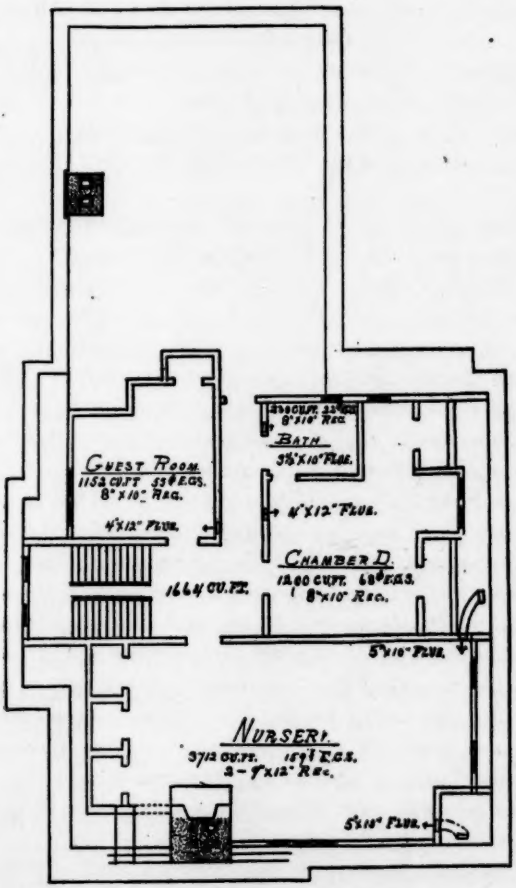


FIG. 5.—THIRD FLOOR PLAN.

DISCUSSION.

The President: You have heard the reading of these two papers. They are now open for discussion.

Mr. R. R. M. Carpenter: Under Fig. 1, on page 3, of the paper, it states: "Taking a certain type of heater, with a grate 30 inches in diameter, that has 150 square feet of heating surface, one of the same type, with a 21-inch grate, has 100 square feet of heating surface." On the following page it states that with a grate 21 inches in diameter, it has 150 square feet. I would like to inquire which one of those is correct.

Mr. Oldacre: They are both correct, as far as that is concerned. There is no name mentioned, there is no particular type taken. It was the simple fact that one had 150 square feet of heating surface and the other 100 square feet of heating surface.

Professor Kent: What was the outside temperature where these tests were made mentioned on the last page?

Mr. Oldacre: I don't see how this is to be construed as a temperature test. The purpose of that test shown there, if you wish to call it such, was simply to make an examination to get an idea of the relative distribution at the time, not as regards the temperature, that could be had in the building or the house. I will say, however, that the test was taken at a time when the thermometer stood at 18 degrees above zero.

Professor Kent: I should like that to be added to the paper for the record. There is another thing which I should like to ask in reference to the table showing the proportion. The proportion of the heating pipe area to the space heated ranged from 1 to 10 up to about 1 to 45; and the proportion of heat pipe area to the equivalent glass surface from 1 to .6 to 1 to 2.5. I would like to ask if that was made according to any rule of proportion? In other words, was the pipe dimension settled on first, and then the equivalent glass surface and cubic contents of the building divided by that area to get these figures in the last two columns, or was there some ratio proportioning it up in the first place?

Mr. Oldacre: The paper does not go into any theoretical considerations whatever, therefore they are omitted entirely

in the paper. The purpose of it was simply to show a plant in actual operation and in working order, which had been designed, I may say, from certain formula. And the performance given there is simply the result of such formulated rules. I would say that in designing that I used certain formulas, and made certain allowances for exposure, and for the difference in the position of the flue, whether, for instance, it was 20 feet or 30 feet away from the heater, or only 6 feet, and whether it had a pitch of 45 degrees, or only 6 degrees, or whatever it might be.

Mr. Chew: The gentleman has already admitted that he has a system, and I am somewhat familiar with it; and I would request, in behalf of the Society, that he finish this paper, not necessarily in this discussion, but at some other meeting, giving his basis and his formulas, and all that sort of thing, which will then make this paper complete. Mr. Oldacre is capable of giving that information, I know, and I hope he will do it.

Mr. Oldacre: I shall be very glad to explain the basis of the formulas by a demonstration on the blackboard, if necessary.

(After going to the blackboard): I would say that the first question taken up is the question of the cooling surface. Secondly, we have to take into consideration the wall and the glass surface reducing that to equivalent glass surface. I believe it is recognized pretty thoroughly, according to the experiments of Wolff and Péclet, that one square foot of glass surface does about as much cooling as an average wall 4 feet square, that is, the relation is 1 to ¼. Consequently if we take one-fourth of the net wall surface and add it to the actual glass surface, we have the equivalent glass surface. We would first then have G. S. + ¼ W. = E.G. S.; that is to say, the glass surface (G. S.), added to ¼ of W., which is the wall surface, is equal to E. G. S., which is the equivalent glass surface.

Now, the next consideration is the difference of temperature, between the prevailing temperature outside and the desired temperature inside, and the difference between the two affects the amount of heat required to do the work with the same amount of glass surface. For instance, let t equal the temperature outside and t′ equal the temperature inside. Then we have

$$t - t' = \text{the difference in temperature,}$$

but the cooling effect is dependent upon the amount of equiva-

lent glass surface, multiplied by the difference in temperature between the two surfaces, from which we have the following:

$$E.\ G.\ S. \times (t - t').$$

Now a certain amount of air must be brought into the room at a certain temperature that the room may be heated to a designated temperature. Each cubic foot of air raised one degree, I believe, is supposed to bring in .0177 of a heat unit per degree of difference of temperature, so that if we bring the air in at 140 degrees, we would practically have 140 times this number or 2.478.

Now the air of that room must get out of the room as speedily as the air comes in or the other air cannot come in. But the air leaving the room will carry out its proportional amount of the heat, which, if the room is to be at 70 degrees, will make it carry out 70 times this figure (.0177), which is 1.2390, which, subtracted from this other number (2.478) is practically one.

Call this the effective value of the air, multiply that by the velocity of the air entering the room, which in this case we will assume to be 4 feet per second, which will give 14,400 feet per hour.

Dividing that by 144, which is the number of square inches there is in a square foot, it will give you the square feet in area that the heat pipes should have to heat the room, under theoretical considerations, without taking in any other necessary factors as regards the length of pipe, its pitch, relative size of the pipe, or the amount of friction.

Professor Kent: That shows that you cannot proportion the area of the pipe from the equivalent glass surface without taking into consideration these other things. If we take the area of the pipe first in proportion to the equivalent glass surface and then the proportion of cubic contents of the space heated, we shall get the strange result shown in the case of the equivalent glass surface, where one pipe was four times as large as another, and in the case of cubic contents that one pipe was five and one-half times as large as another. So the rule which some people would use, namely, that so much pipe is required for so much cubic contents, would not give the correct rule, but it must be figured in the way Mr. Oldacre shows, taking into consideration not only the equivalent glass sur-

face, but also the difference in temperature, and the assumed velocity of the air in the pipe. I don't know how he gets at the assumed velocity.

Mr. Oldacre: I assume the velocity from hundreds of tests that I have made with anemometers. I simply struck an average, and that is about what I would expect to see where the flue was not too small. Taking furnace heat you will find pipes 2¼ by 10 inches; I have run across them at 2½ by 20 inches; and I know another case where the pipe is 8 inches square. The friction is entirely different in the different cases, and if you are compelled by the construction of the building to run up a flat pipe you have to allow a very much larger area in the pipe than you would if you had the pipe in the correct shape, which is as nearly round as possible. I would be glad to go further with Professor Kent, and if he would pick out any particular case where the proportions seem to be extraordinarily large in proportion to the equivalent surface I would be glad to point out to him the reason which caused that. In some cases there are flues in the house which have got at least nine changes of direction in the flue from the time it leaves the heater until it comes out at the register; yes, there is one case where there are eleven changes. In that case the flue is large in proportion to the equivalent glass surface or cubic contents. In other cases, where the pipe is quite small, or, rather, the relation is quite small, it has been because the flue is very direct. Take chamber C and you see a relation of 1 to 2.6. In that case the pipe is in an outside wall. It has a western exposure. The principal part of the glass surface fronts to the west, a small amount of glass surface fronts to the south.

I would say that in most of the experience which I have had people want their houses heated the same all through from the first to the third floor, and it is almost necessary to prevent draughts and to have as even a distribution of heat as possible.

Professor Kent: What is the difference between chambers D and C? One has about twice as much pipe area, proportionally, as the other.

Mr. Oldacre: Chamber C is on the third floor and has a different exposure; the other is on the second floor. The velocity is greater on the third than it is on the second floor.

Professor Kinealy: I wish to ask a few questions. I notice

that you use a velocity of 4 feet per second. Is that for all the floors?

Mr. Oldacre: It is not. It is only to put in some figures. You may make use of 4 or 6 or 3 or any other figure.

Professor Kinealy: And you take different velocities for the different floors?

Mr. Oldacre: Yes, sir.

Professor Kent: I think that when Mr. Oldacre makes these additions to the paper it will be one of the most valuable ever written on the subject of heating by hot air, and I wish to encourage him to give all the information he can.

Mr. Chew: I feel again that I ought to make a statement for Mr. Oldacre's benefit. This paper was prepared partly as the result of Mr. Harvey's suggestion as Chairman of the Tenth Anniversary Committee. Some sort of showing had to be made, and this paper is one of the showings. Mr. Oldacre had done this job long ago, but the paper was not written and printed until Friday of last week, and it is one of the few papers ever brought into this Society printed for distribution by the member who brought the paper. One reason why he has not got into it all he would is lack of time. This winter began quite early and is rather severe, and he has been busy with things that pay better than writing papers.

Mr. Switzer: I can appreciate the feeling of Mr. Oldacre in coming before the Society and undertaking to compute and make calculations before them, and I would agree with the remarks of Professor Kent and Professor Kinealy, and would suggest that they prepare a memorandum of such cases as interest them and submit them to Mr. Oldacre, and have them come into these Proceedings. Referring the discussion to a later meeting would not, I think, make the paper quite complete, and I would hardly approve of that feature.

Referring to the paper itself, I would say that I regard this paper as a very valuable bit of literature, not alone for this Society, but for the fraternity of furnace mechanics throughout the land. We have here a great deal of information and data to lead them on in their work, which will certainly bring the standard of furnace heating to higher levels. Although the idea of the battery system of furnace construction is not entirely new, Mr. Oldacre has brought out certain features that are in-

teresting and instructive in regard to the proportions, capacities, locations and arrangement of piping, as well as the location of the registers.

Referring to Professor Carpenter's paper on the matter of the moisture and evaporation in furnace heating, inasmuch as my own practice is in furnace heating, I have strongly advocated vapor fans in furnace construction of sufficient capacity and so located as to secure liberal evaporation of moisture within the radiating chamber of the furnace, with the result that a more satisfactory and efficient temperature can be maintained with the evaporating pan. Reference was made to Mr. Loveland's paper by Professor Carpenter, where it was stated that the air supply to the furnace in question was taken from the building. In my own opinion, had the air supply been taken from the outside the results would have been far more satisfactory in favor of the water pan. In my observations on this subject, I have found that the advantage or necessity for water pans in furnace construction varies with the different climatic conditions in the different sections of the country. Where furnaces are in general use, as, for instance, on the Atlantic seaboard, where the atmosphere is heavily charged with moisture, a vapor pan has no appreciable advantage if the fresh air supply is taken from the outside. But in the middle or northwest or Rocky Mountain sections of the country, at high altitudes, the air is much drier; and better and more satisfactory results can be achieved with a vapor pan in those sections. Of course there has been and will be, no doubt, a great deal of criticism in regard to the cleanliness maintained by the operators or users of furnaces in keeping the water pan well cleaned and well supplied with fresh water. In an effort to overcome in a measure that feature, a number of years ago, certain manufacturers were interested to have their vapor pans made of suffisient size and so located as to ensure greater cleanliness. They also made porcelain enameled vapor pans with that end in view, and also to avoid the corrosion of the cast iron. They found that this was of material advantage and benefit, and it was used quite extensively. But within recent years the manufacturer concluded it was only a waste of money to enamel the water pan, and at the present time I doubt whether there is any manufacturer enameling the water pans he sends out. A

great majority are eliminating them entirely. I think it is a great mistake, and I trust that this paper will bring out more clearly that feature of the subject.

Mr. Oldacre: I wish to say that I have no faith whatever in vapor pans or water pans in heaters, and I think that they are more of a detriment to the heater than an advantage. And for this reason: The water pan, if put into the heater at the bottom —I speak of it as a water pan, even where it is merely the bottom of the heater, and where it does not receive any heat—is a means of running dust and dirt into the heater. And you often see, in cold weather, that the water pan, instead of having water in it, has ice, showing that there is no evaporation going on, and no moisture being taken up by the air into the apartments. If you put one on at the top, it would almost take the time of a man standing there all day to keep it filled with water, and then it would boil away so much water that you would have more water in your house than you wanted. Furthermore, it cannot be placed in the heater as some are constructed without stopping up the flue passages or air spaces in the heater. Vapor pans are one of the principal causes of fire pots burning out in heaters, simply because the air is not allowed to come in contact with the heating surface. You can easily burn out iron or destroy its good qualities, practically consume it, by keeping the air from passing over it, or keeping water from passing over it, whatever may be the cooling medium. I have made some experiments in regard to the facts, and in regard to the relative humidity of the atmosphere in a room. In one case I had a room or space with 12,000 cubic feet of contents, and I had thermometers put in so as to get the temperatures, and wet and dry bulb thermometers, and I found that by evaporating 68 pounds of water, or about eight gallons and a half a day, that the relative humidity was raised only five per cent., that is, the increase was not five per cent., but the relative utility of that room without any water at all was 35 per cent., and by the addition of this amount of water into the air the relative humidity in that case, at the same corresponding temperature, was about 40.

Mr. Wolfe: I hardly believe that the arrangement with the water pan in the furnace is practicable to add to the supply of humidity in a building. Dr. Billings, in his treatise on warm air and ventilation, gives a table showing that at 59 degrees

the atmosphere will carry one-eightieth of its weight in water, and every twenty-seven degrees that you rise in temperature you double its water carrying qualities, running it up to 204 degrees or thereabouts, when there is complete saturation, and going back to 17 degrees below zero, where it will carry no moisture whatever. That would mean the raising and lowering of the water pan in the furnace suitable to the condition of the weather from day to day, as the temperature might change. In indirect heating it can be easily accomplished. They do it in the Capitol in Washington. They have a steam device, automatically regulated. When the atmosphere contains so much humidity the steam is shut off; when it needs more it is automatically turned on, and it distributes spray into the air ducts that supply the house.

Mr. Richardson: Regarding this question of water pans in the furnace and the evaporation required, it always struck me as being very funny that the minute a man has any trouble with his throat or lungs, the first thing that the doctor says is, if he gets a bad case: "This climate is too raw for you; there is too much moisture in the atmosphere. What you want to do is to get out to Colorado, or Arizona, or to St. Paul, where the air is dry, and get away from this moisture." I have found that with hot air furnace heating, taking the air from out of doors, people are very much less liable to get cold, or to be sick, or to take these various diseases, than they are where there is a lot of water in a water pan, that is, where there is a great deal of moisture put into the air artificially. Furthermore, if you take a room that is heated with a radiator, be it steam or hot water, without a constant supply of fresh air from out of doors, the air becomes oppressive, and those people who live in those rooms, the men who have those radiators in their offices, won't have them in their houses if they can help it, simply for this reason, that they have headaches, that they have a very close air that is being heated over and over again. I don't think it is so much the dryness as it is the fact that the life-giving qualities of the air have been taken out of it from constant rebreathing.

Now in regard to this question of a double furnace, the one great advantage about the double or battery furnace is that you can use one furnace in moderate weather instead of using two.

That plan of setting furnaces has many and very decided advantages. There is one point in this paper which I see criticised very strongly, and that is the fault of putting in two furnaces into a battery form with only a 21-inch fire pot in each one of them, as it is very well known it is very hard work to keep a fire over night that has only got a 21-inch grate, especially in cold weather, where the winds change in the night, unless you have an automatic arrangement; and even then you are apt to find the coal burned out in the morning. When you have the battery form, you should not have less than a 24-inch grate.

Mr. Oldacre: In reply to the remarks which the gentleman has just made, I will say that I don't wish to appear to defend this paper. I hope it will be criticised freely. It was prepared for that purpose. But I must take exception to the idea of being unable to keep a fire over night in a 21-inch grate. With such heaters as we have used, we have no trouble in keeping the fire over night, if the fire is properly cared for, with 14, 16, 18, or any other inch fire pot. The reason I prefer two 21-inch grates to one 30-inch grate is that in moderate weather a large fire is very hard to take care of and properly regulate. One of the principal complaints we get in our work, where we put in a heater as large as 30 inches, is that they get too much heat in moderate weather. And there is another thing, a heater which has a 30-inch grate area will burn more coal than the 21-inch will burn, that is, than two 21-inch grates will burn, for the same relative amount of work, and this is true even though the surface might be the same. There is a certain amount of coal consumed in the center of the fire, which heat is not brought in intimate contact with the prime heating surfaces; and for that reason I have found that you do more work with less consumption of fuel, and you have no trouble in keeping fires over night, in accordance with this plan, and in moderate weather you can use one heater. I particularly call your attention to Fig. 1 as illustrating that. I don't know whether others have used a top of similar construction, but the top there was built with that idea; and that is one of the reasons why I spoke about the distance there was from the top of the heater. The lines across are constructed on an angle of very nearly 45 degrees, with the idea of diverting part of the heat from one side to the other or opposite side of the house;

and by means of dampers I have been able to get a pretty fair distribution of the heat through the house with one fire going.

Mr. Wolfe: Speaking from my kindergarten experience, which I referred to this morning, I think Mr. Oldacre is a little unfortunate in his selection of a furnace. I can remember when I was a youngster going around to the foundry of Mr. Stewart. Old Mr. Stewart made two inspections. He made one in the daytime relative to the quality of the castings, and one after dark, at night, when he would go through with a lamp and put it in the ash pit; if he could see a light through the damper in any way that stove was condemned, and had to be refitted. The old Stewart stove was so made that if the damper was entirely closed to the air supply the fire went out. I have had experience with a large fire pot furnace. I have taken a furnace with a 36-inch fire pot, in a large building, and have seen it fired, coaled it myself, and I have found that, without touching it, there was a fire at the end of seven days. When we shook down the fire and started the fresh fire we had the building hot in a very short time. I know that to be so. And if a furnace is properly made and well fitted with dampers, a large fire pot is equal to a small one for holding fire; and it is also more economical in coal, as far as my experience has taught me.

Mr. Switzer: Referring to the question of the size of the grate area, as spoken of in the paper presented by Mr. Oldacre, and the discussion that has been brought out regarding the sizes of the grate areas for maintaining fire and getting results, I still adhere to the statement I made in my previous remarks, to the effect that the difference in the various sections of the country has a great deal to do in relation to the area of the grate surface and the capacity of the fire pot and the furnace installed. In the paper that Mr. Oldacre has submitted he refers to a residence in Philadelphia where these results have been achieved. It is highly creditable to that locality, but I want to go on record as saying that those results would hardly apply in a satisfactory manner to other sections of the country, particularly to the northern portions of the State of New York, where the temperature during the past month has been 30 degrees below zero, as compared with the Philadelphia section, where it has been about zero. Consequently, the skill of the engineer or the mechanic in installing the apparatus must come

XUM

into play in order to get the best results in accordance with the conditions of climate and of the locality where the work is situated. While the data contained in the paper are a desirable addition to our literature, I must say that no prescribed rule will apply to all the various climatic conditions throughout the United States.

Mr. Barron: I want to make one comment upon the exposition of Mr. Oldacre when referring to Mr. Richardson's remark that you cannot keep fire as well in a 20-inch as in a 30-inch fire pot. The diameter of the fire pot has nothing to do with keeping in the fire for any length of time. The whole problem is the depth of the fire pot. It is a question of depth, diameter has nothing to do with it whatever, in my opinion. So I should say with reference to Mr. Oldacre's statement that two 21-inch fire pots are far better than one 31-inch fire pot. I know from experience that there is no difficulty in keeping fires in a 20-inch fire pot if the depth of the fire pot is correctly designed.

Professor Kent: I had an experience with an 8-inch fire pot which may be of interest. I had a first rate fire of pea coal burning briskly, with everything in first rate shape, in an 8-inch fire pot. Then I closed off all the inlets, so that not a bit of air could get in, hermetically sealed it with paste, and in an hour and a half the coal was black and the fire dead, simply due to radiation from the fire. Professor Carpenter repeated that experiment.

Mr. Barron: Will the Professor give the depth of the fire pot?

Professor Kent: About ten inches. A little stove it was, with a fire-brick lining, a sheet iron stove, sheet iron casing. And in order to find out whether it is possible to introduce air in the method described by Schlicht, that is, back through the smoke pipe, we shut off all the air down below, absolutely shut it off, and the result was that instead of air coming in back through the pipe, there was no air that got into the fire pot at all, and the fire went dead out, black; and we repeated the experiment several times, and every time the same result was shown. There was absolutely no transmission of air to the fire through the chimney pipe, but the fire went out. This was just the opposite of what was said would happen, namely, that the fire would be kept in by air from other sources. If we

had so much as a pin hole below the fire would keep alight, but by stopping up all the leaks the fire went out, dead out, from radiation. So that the diameter of the fire pot must have something to do with it, for this little fire pot could radiate enough heat away to cool it out in an hour and a half.

Mr. Oldacre: I would like to say that for six years I have had an opportunity to observe a heater of 18 inches in diameter, and it carries a depth of from 15 to 17 inches of coal. That heater is filled with coal about 4 o'clock on Saturday afternoon, and it is never touched again until Monday morning about 8 o'clock. And in that six years' time, while the heater has been running, and it has been running every winter, the fire has never gone out. The heater is not lined with fire bricks, but the fire pot has quite a large amount of extended surface. We have never experienced any difficulty whatever in keeping that fire burning that length of time.

Mr. Barron: I get up again. I intended to speak on Professor Carpenter's paper, but I was diverted from my intention. I have never seriously considered the problem of humidity in heating, and I don't think the average heating man ever considers it; and when Mr. Richardson said that he did not believe in water pans in a furnace, I thought that was the commonsense, practical view of the subject, and that humidity is not a very live question to the heating engineer. But Mr. Harvey described a library in Detroit with an indirect heating system, in which the vapor tank was like the ordinary tank, with a ball float, that kept the water supply up there. And it was absolutely necessary in that library building, where the air could not be allowed to get very dry, as it would affect the book covers. So I can readily understand that humidity becomes of importance sometimes, though I have never had any experience of it at all. But for certain purposes, if you take an institution, for instance, a sanitarium, organized for the purpose of treating diseases in their incipient indications—for example, excessive loquacity—it might be possible that a certain humidity would be required in heating, and it would be well to know just what humidity was required, and how to get that. So I hope Brother Harvey will describe his arrangement in the library in Detroit for us.

Mr. Berry: I was very glad to hear Professor Carpenter's

paper on humidity. A great many times when we are dealing with the user of heaters he seems to have some kind of an indefinite notion that the vapor pan is going to be a grand thing for him. He has a kind of idea that if he had a hot water system in some way the hot water system would permit moisture to come out into the air mild and warm. I was unable to run across any recent practice of putting the moisture into the air, and I tried some experiments on a modern type of heater, with a radiator at the top, and to avoid stopping up the air passages I placed a pan, four inches wide, three inches deep, round the top of the radiator. This did not obstruct the flow of air to any appreciable extent, and placed the moisture all around the heater in front of all the various openings. This was connected through the casings with a one-inch pipe, through the tank outside, which was kept filled with water by a float valve. I found by that device that while it evaporated a good deal of water it did not have any result very beneficial on the house, so far as I could detect.

In regard to the question of Mr. Oldacre's battery system, I think that one of the greatest values of the battery system is in the large increase in the proportion of heating surface to grate surface. A large heater has a less proportion of heating surface to grate surface than a small heater has, and by using two separate heaters a great deal more efficiency is realized from the coal burned than when one large heater is used.

Mr. Barron: I would like to hear from Mr. Harvey.

Mr. Harvey: I think that this question has already been so thoroughly discussed that it is hardly necessary for me to speak. What Mr. Barron has referred to was a library which I heated twenty-five or thirty years ago. To attempt to go into any detailed explanation of it would consume too much time. It simply consisted of a gold pin radiator, in flues under the floor, with pans of water eight inches deep and the full width of the opening, with a ball cock attached to the pipe that supplied all the pans. The pans were set on a level and the water was continually kept at that level; and the air, after passing through the heater, passed over this body of water. How much it took up I can't say, because I was not doing it to get any experimental results. But at that time there was a great deal of talk about dry air, and it was a noticeable fact that the bind-

ing of the books kept in better shape than they have since the new additions have been put on to the library, where no water for evaporation is in use.

Mr. Barron: I would like to ask Professor Kent if there is any injurious effect from decomposing water in the vapor pan, any effect injurious to health?

Professor Kent: Not from decomposing water, but from decomposing the things incidentally contained in the water, and those may be anything under the sun in a city like New York. Somebody mentioned horse manure to-day; that may be there, or pieces of hair, of woolen goods, of woolen carpet; and when the water is boiled out of the pan these things and the bacteria begin to cook, and the smell you get is no doubt the smell of burning organic matter. By getting rid of the pan you get rid of that part of it. But even without the pan you may have the smell of the burning of the dust that collects in the hot air pipes. In either case you have warning that the fire is becoming overheated.

Mr. Snow: The system designed by Mr. Wolff in some of these New York residences consists in placing steam coils in large evaporating pans; the supply of steam to be automatically controlled. In that way you can regulate the humidity. But in a furnace, if you put the pan low down the evaporation is so slow that you get no appreciable effect in the rooms above; and if you put it above, it is difficult to regulate, and it is likely to make steam, or evaporate so rapidly that you get a disagreeable odor in the rooms above. So that you have two horns of a dilemma to contend with in furnace heating, whereas it may be regulated easily in steam heating.

CXXVIII.

TOPICAL DISCUSSIONS.

TOPIC NO. I.

"Should it be considered the work of the Society to secure and preserve records in detail of the different types of heating systems in different types of buildings?"

DISCUSSION.

Mr. Wiltsie F. Wolfe: Mr. President, to open the matter for discussion, it seems to me that it would be very much to the interest of the Society and its future members that we do preserve such records as are indicated relative to the present and even some of the later methods of heating and ventilating buildings at different times and by different methods. They will become obsolete in time, but would be of interest in the archives of our Society.

Mr. Jellett: One thought that I have in mind in connection with Topic No. 1 is this: In the early days of the National Association of Master Steam Fitters there were a number of papers presented. I think this Society ought to secure copies of those papers and preserve them. There was one by Mr. J. J. Walworth, I think, on the early days of steam heating. Mr. Bates presented two or three papers at different times. Mr. Nesbitt and Mr. Arthur Walworth also read papers. These papers should be kept among the records of this Society, and I have no doubt they can be secured from the National Association of Master Steam and Hot Water Fitters or else from the engineering publications issued at that time. I believe they were all published soon after the conventions each year. I believe it would be of great interest to the Society to add these to our collection of literature on the subject.

The question of securing and preserving records in detail is a very expensive thing, and yet it is of great value, and it means a good deal of work on the part of this Society. I doubt if you

can do it successfully by turning it over to a committee. It ought to be the work of some one man when the Society is in a position to pay for his services. A great deal has been published in trade papers at different times that if collected, indexed and put in shape would be very valuable information, and I think it would be a good thing for the Board of Governors to give consideration to this matter, and see if there is any way possible by which they can start a filing system of this kind. They may not be able to do it this year or next year, but if they start it the members generally can assist by contributing such extracts as they may be able to collect from time to time and from their old data on hand or old publications and from other sources which are not usually available. I would like to see something of the kind done. I believe it would be to the interest of the Society.

The President: A motion to that effect calling the Board of Governors' attention to the matter, I think, would probably reach the point in better shape, if you make such a motion.

Mr. Jellett: I would make such a motion, that the Board of Governors be requested to devise means by which the Society may collect the literature of heating and ventilation wherever it can be found; and that the membership be encouraged to present technical papers describing actual working systems which they have installed.

Mr. Wolfe: I second the motion.

The President: You have heard the motion, gentlemen.

Mr. Wolfe: I would like to give a little example that came under my personal notice. One of the best heating and ventilating engineers of England asked my opinion of a certain method of heating. It had been presented before the Society and was illustrated in one of our annual books. I said to him you will get a better idea probably by reading this over carefully, and I loaned him the book for a week. It was not sent back. In a week he sent me the price of the book, and said that he preferred to keep the book—there was more information in it than he had found in any half a dozen books on heating and ventilation that he had ever read. I think the more thoroughly we go into the matter the greater interest will we create among engineers who are not members but might be induced to become members by reading our books.

XUM

Mr. Chew: What Mr. Wolfe says about the value placed on that particular copy of the Proceedings of the Society suggests the value of a description of some of the different pieces of work done by the members, and I think that one of the objects of that topic was to impress upon the members the desirability of that kind of descriptions. The President's address recommends that the younger members of the Society or the humblest member of the Society can give a complete detailed description, with all the dimensions, proportions and other things of some piece of his work, and it doesn't make any difference whether it is a drying kiln for lumber or what it may be. The very fact that this Englishman would not return the book, but would rather pay for it, shows the value of papers describing working systems. This Society gives an opportunity to every member to bring before it a description of some piece of work, whether it is direct steam work of the factory type or the blower systems, furnishing not only fresh air but hot air—the description of work is what makes our Proceedings valuable.

Mr. Meyer: Mr. President, for some time back I have kept articles bearing upon power plants, heating and ventilation, and found them valuable for reference. I think if the Society could start a library and obtain data bearing upon heating and ventilating subjects it will be very useful to some people, providing the data could be put in accessible form.

Professor Kinealy: I had occasion not very long ago to look up the heating and ventilation of hospitals and found that if any one would refer to the technical and trade papers he would be surprised at the vast number of data he could get. It is easy to get more data than really you can handle and get indexed. You can buy an index of general engineering literature that goes back to, I think, 1884, and in that you will have a notice of the description of every heating and ventilating plant that has appeared in any one of the respective technical and trade journals. As to the collecting of these data in regard to one class of buildings and publishing them in the Society transactions, noting, for instance, how many per cent. of hospitals are heated by the plenum system, how many per cent. have a plenum fan and an exhaust fan, how many have direct radiation without any ventilation, how many have direct radiation and fan, and so on, that is simply a matter of work. But it is

exceedingly valuable when you get through. It simply means to have some one to do that work, and when I heard that letter it struck me that he ought to do the work for his particular buildings and then give us the results; not sit down and ask us to do the work when we do not need it, and give it to him. Now, further, we can get data as to temperatures. I have gotten from the United States Government the record of humidities going back, in some instances, for twenty-five years. The question as to what temperature a system ought to be designed for when the average temperature during the winter is a certain number of degrees is one that has been discussed before this Society. I think it was Mr. William H. Bryan who raised that question, and he proposed that—I am speaking now from memory—that heating plants should be designed for a temperature of about 30 degrees less than the average winter temperature. I used to be a volunteer observer in the United States Signal Service, and I got every year a voluminous volume that gave all sorts of information, and I think any citizen can get one of the volumes by applying for it. The gist of my remarks is simply this, that collecting these data is simply a matter of work. It means simply getting the data from existing sources and putting them in such shape that they will be valuable to our members, useful for their particular kind of work. I would like to see it done of course.

Mr. Barron: I want to speak to the motion, Mr. President. The only way to collect data is for a man to keep a card catalogue system himself. For this Society to do it would require a building larger than the Astor Library, and that is prohibitive. Your Board of Governors cannot do it. There is no use of our recommending them to do it, because the cost is prohibitive at once. It is doing a lot of work that every engineer has to do for himself.

Mr. Wolfe: I do not agree with Mr. Barron. I believe we can take up certain general lines, such as direct heating, indirect heating, blower work, exhaust work and work of that kind—in a general way, make it as a history of the art. I believe it ought to be in our books. My personal experience, of which I told you, leads me to think this. We know it interests people. I think it is within the province of the Society to put it in and make history of the art, not only from the present time, but also refer-

XUM

ring to the past. I happen to have a couple of volumes that go back to about 1700. They are welcome to the use of those who may wish to take it up. They would be surprised to see how many old ideas are being used to-day.

Mr. Snow: It appears to me that it would be practicable, if the engineers here are urged, until a little enthusiasm is created, to have them turn in the results of tests they may make from time to time, on coal consumption, on flue velocities, on the horse power required to drive fans or the delivery of fans or what not—anything that comes up in connection with their work which in itself they might not consider of sufficient importance to use as the basis of a paper, but which, if sent to the proper person—the Secretary or some one duly authorized by the Board of Governors—could be classified, and after a sufficient number had been collected to warrant it, I think some member of this Society could be secured to take the data that had been collected on that particular subject, go through them, classify and tabulate them, and put them in shape and prepare an interesting paper and something of value for this Society. These different subjects treated would form the basis of papers which would be presented from time to time. It seems to me that that would be a practical way of handling the matter, and we would thereby get the results of many tests that otherwise would never appear in print.

Mr. Meyer: Regarding the question, "Should it be considered the work of the Society to secure and preserve records in detail of the different types of heating systems in different types of buildings?" it seems to me that such records could be obtained by preserving articles clipped from the technical press. I have been collecting such articles for some years back, when connected with the staff of a technical journal, and found them of much value. I tried to card index the articles quickly, but found that it took too much time, and I could not find the articles when I wanted them. In work of this kind I believe it to be more satisfactory to tear the pages out of the papers and classify the different articles, putting them in heavy envelopes of the full size of the pages of the paper, so that folding will not be necessary. I classified the articles under such headings as "office buildings," "hospitals," "schools," "residences," etc., perhaps sub-dividing articles into "heating

by hot water or steam." If I wanted to find an article on "school heating," I could turn to every article in my possession upon that subject in a very few minutes; whereas, if articles upon the same subjects are placed in a number of envelopes, with a card index system to locate all the articles upon the subject, it will be found that considerable time and trouble is necessary to get at them. The Society gives its Proceedings to the various technical papers, and I do not see why it cannot obtain copies of the technical journals and place upon the Secretary the additional duty of clipping and classifying articles of interest to the Society. Perhaps the gentlemen who suggested the question might be willing to do it.

A Member: Why not put this matter up to the Committee on Tests and Standards?

Secretary Mackay: I believe that the intention of the proposer of this topic was that the Board of Governors or the Society should encourage the writing of papers by the members descriptive of heating apparatus, not only of the apparatus as it was placed, but also of the results actually obtained from it in operation, consumption of fuel, things of that sort which would be a matter of record, as Mr. Meyer mentioned, and in that way it would cost the Society little or nothing for the record. It would be a matter of record in our Proceedings, and would be sought after by others as well as ourselves. I believe that was the real intention of the topic, and that it would not entail any additional work on any member of the Society or its Secretary.

Mr. Wolfe: I think that a committee or an individual to whom may be assigned by the Board of Governors the duty of collecting these data should be empowered to act or employ some one to act for them and compile the records of the subject of heating and ventilation and the history of the art. It has been suggested to me since I have been sitting here that a description of one particular building is as good as fifty. Let them go back as far as they can get the data, boil them down as much as possible, and make them part of the records of our Society as a history of the art of heating and ventilation since anything has been known about it. I have a book that goes back to 1700 and they were talking about ventilation then. When we come down to the true facts of the case, most of us

XUM

here know that the first man who really started in the United States to talk so-called scientific heating and ventilation was Mr. Smead. We all think he was wrong, and he was no doubt wrong, in a good many things, but he is the man that taught us or forced us to come in with elaborate plans and take a scientific method, no matter whether we knew what we were talking about or not. He did a whole lot of good.

Mr. Chew: While it is well enough to delve into ancient history—1700—I doubt very much whether that is as interesting as 1895 or 1903—the work that is being done now is what is bothering every man. The art is changing, advancing, and while some inferences can be drawn from plants installed twenty-five years ago, the best thoughts of our members of to-day are what the Society wants to preserve rather than waste time in the study of discarded methods.

Mr. Smith: I think that is the wrong idea. Old work that is obsolete is often valuable stuff to know about. A man who came to see me some weeks ago said that he had devised a very ingenious scheme that he wanted to talk about and possibly get patented. He said he had occasion to ventilate a school in the country. While he did not care to go to the expense of a fan, the building was so constructed with a central flue that he conceived the idea of taking his ventilating ducts into it and, in order to create a draft, put a coil up in the shaft. I said, "You mean an ordinary aspirating coil?" "Why," he said, "did any body ever use that before?" (Laughter.) I think it would have been useful for that man to have some ancient history.

Mr. Chew: I do not consider that ancient history in the sense in which I used the term. Aspirating coils are being used frequently in to-day's work. It is the modern application of aspirating coils that is of interest to every modern engineer.

Mr. Smith: Every one has seen men without data, without complete information, spending a great deal of time working on something that has been tried and found worthless and rejected. It would be a good idea for them to look into ancient history.

Mr. McKiever: I would like to offer an amendment, that the Board of Governors, through the Society, invite the members to submit papers in a technical form, which could be incorporated in the Annual Proceedings of the Society, my idea

being that there may be members who have interesting jobs which are going on and which may be completed and tested in time to be incorporated in the Proceedings. A great deal of the matter which is in the technical press is written only from the contractor's standpoint, and does not contain the data which we should have. I think if a circular was sent out and it made known to the members that any data which the Board of Governors considered of sufficient importance would be incorporated in the Proceedings, we might get a lot of information in that way.

The President: Do you offer that as a suggestion to the Board of Governors?

Mr. McKiever: Yes.

The motion as amended was seconded and carried.

TOPIC NO. 2.

"Could the interests of the purchasers of heating systems be conserved by a closer relation between the heating engineer and the manufacturer of apparatus?"

DISCUSSION.

Mr. Barron: This is a humorous question, really. You know that in France, and I believe in Germany also, the manufacturer installs the apparatus, and I do not think there is any doubt that if our manufacturers did the same thing we might be better off than we are. There is no reason to my mind to prevent it. The business has developed differently in this country from abroad; that is all. But there certainly would be less dissatisfaction. There would be more satisfaction to the customer. The implication of the question is that the public who buy the apparatus would be better satisfied. I think from my experience they would, if the manufacturer installed the apparatus and was responsible for all the faults of the manufactured articles that the poor contractor has to stand for now. (Laughter.)

Mr. Lyman: I am of the opinion that the manufacturers would welcome direct suggestions from members of the Society, looking toward probable improvement of apparatus. There are a great many suggestions which are not feasible from the

manufacturer's standpoint which are all right for the skilled engineer and all right here. But when you remember that everybody who runs an apparatus is not a skilled engineer. Manufacturers, I think, are usually justified when they perhaps make the iron thick and build apparatus just as simple as it is possible to make it. Yet I am sure they would favorably consider suggestions from the Society looking toward anything that is a definite improvement in heating.

Mr. Chew: I think I can bear testimony in support of the ground taken by Mr. Lyman. A few years ago we discussed in this Society the proper method of arriving at the capacity of certain goods, and it was not long after that before one of our members was retained by manufacturers in that line to give them a talk, and it resulted in the remodelling of their methods; so that when Mr. Lyman says the manufacturers are ready I believe that is a fact, but that there is need for further assistance from the engineer to the manufacturer I still believe.

Mr. Davis: I think that question is already bearing fruit with the large manufacturers. I think you will find that there is scarcely a large manufacturer of heating apparatus who is not employing technical men to help him out and to get in touch with the heating trade and to remedy the defects that have been brought out in the manufacturing of his goods, and such work will form a further field for the young technical engineer.

TOPIC NO. 3.

"Can a constant relation be established between the areas of cold air ducts, hot air flues and the radiating and heating surface in different systems of indirect heating?"

DISCUSSION.

Professor Kent: I would say, in my opinion, no, and that the relation between the areas of flues will depend upon the height of them and upon the temperature that is carried in the flues. And as these things vary considerably over wide ranges, the relationship cannot be constant. A complex and variable formula would have to be used. I would like to know if any one can specify the relation in this particular case. A steam radiator is put just below the floor, to heat the first story, so that the

vertical rise is practically nothing. Is there any law for calculating how big the register should be right over the heater?

Professor Kinealy: Of course you can establish a constant relation for certain conditions, and that relation is good as long as you have those conditions. But if you have varying conditions then, of course, you have a varying ratio always; that is to say, if you have a certain temperature in your flue, and a certain temperature outside, you can make out a table that will be constant, and under those conditions you can make tests and get almost constant velocities. But that means that you have the control of the conditions that are usually not under the control of human beings, so that the question as it is asked can be answered either yes or no. If you assume constant conditions, then of course you can make out a table giving constant relations; but it is impracticable to work out any relation that will work in practice, for the simple reason that you never get constant conditions.

Captain Reck: I would say that in my office work we apply a certain relation between the areas of the hot air flues and the amount of air that is going through them. But it is quite right that the heights must be considered, so we apply different ratios in the different stories. If you have four feet velocity of air per second then one square inch of flue area will give you one hundred cubic feet of air per hour. That is a very good rule to remember. We calculate, in hot air installations, how much air shall go up the flues, and we have 1.1 square inches to 100 cubic feet; and in the second story it is 0.9, and in the next 0.5, and so on. We have a number of young people in the office, and it is a very easy matter to calculate the flues. And that is a kind of constant relation, because the amount of air corresponds to the amount of heat you will give.

If you have calculated the hot-air apparatus in the same manner as the steam apparatus, calculating for a certain difference in temperature outside and inside, you may also calculate for a certain temperature of the air that is going through the rooms, and you will have always a constant relation between the heat units you will furnish to the room and the amount of air. And if you take a certain constant relation of the square inches of cross section in the flues in proportion to the cubic feet of air, and make that relation different for the different

stories, then you have again a constant relation, only you must remember what height you have in each particular case.

Professor Kent: I would like to ask the gentleman what height he would give in the case I asked about, where the radiator is right under the floor, and the register in the floor, practically not over one or two feet vertical rise?

Captain Reck: We have hot air flues in the wall. We have a height of eight feet, and for that height we have about three feet velocity in the hot air flues. We calculate the ratio then at 1.1.

Professor Kent: In this country it is common to hang the radiators right under the floor, and have the register immediately above them.

Captain Reck: You would have to use a higher coefficient. Perhaps it would be 1.5 in that case.

TOPIC NO. 4.

"What is the prevailing practice in proportioning water heaters in hot air furnaces to the work to be done?"

DISCUSSION.

Mr. Chew: Years ago it was found quite difficult to heat rooms some distance from the hot air furnaces and, as a makeshift, coils of wrought iron pipes were introduced into the hot air chambers. And at that time, purely on a rule of thumb basis, sometimes the coil was large enough to boil the water, and it continually overflowed the expansion tank, and at other times the coil was so small that it was found necessary to run the furnace very hard and overheat the air and give an excessively high temperature in the parts of the house heated with hot air, in order to secure anything like a comfortable temperature in the parts of the building that had radiators. That is where arise troubles of many furnace men who are recruited from the tinsmiths and are not familiar with steam or hot water heating. They find considerable difficulty in attempting to do what has become a phrase, "balance the system." Again, there was an erroneous idea entertained by many persons that after a hot air furnace had accomplished about its limit in heat-

ing capacity, still there might be realized an additional power by the introduction of a coil in the fire chamber. The more experienced men found that you cannot eat your cake and have it. If the fire is doing its maximum in heating the house by the hot air process, it is hardly probable that it can heat any considerable amount of additional space by the circulation of hot water through the water heater in the fire chamber and then through the radiators located in distant rooms. The fact that rooms located at some distance from the furnace can be heated by radiators connected with a water heater in the fire box has led to the use of a system by men of larger experience and more practical judgment who have had considerable success.

Mr. Snow: A while ago I wrote a little article for the "Metal Worker," in which I condensed the results of some tests that I made about eight years ago on some combination hot water heaters in furnaces. We rigged up furnaces with various attachments and had connected with them a number of radiators, separately valved, so that we could see how much surface would be carried per square foot of radiating surface in these different kinds of sections; and the results are given in a summary contained in that article in the "Metal Worker" for December 12, 1903. The first is "Cast Iron Sections Suspended above the Fire." A number of different forms are in use that may be bought separately, or re-adapted to certain types of service as the case may require. There are a number that may be bought, and may be used in almost any type of furnace, and for those it was my practice, when actively engaged in that line of work, to allow about fifteen to twenty square feet of hot water radiating surface to each square foot of heating surface in those sections above the fire. And for sections in contact with the fire—those in brick-lined furnaces which you are familiar with are simply slabs that are the same shape as bricks and take their place, one, two or three being used as the case may be—in those I have used a rating of from forty to sixty. It is perfectly easy to heat seventy-five or a hundred square feet of radiation with one square foot of fire surface; but the smaller ratings are based on about eight-hour runs. True, you can stand over a fire and get almost any result, if you burn the coal fast enough, but for practical purposes we want to give a rating that will be based on a fire running without attention for a period of seven or eight

hours. The next rating is a combination which is frequently used—using the fire surface, the heating surface in contact with the fire, supplemented by the surface suspended above the fire. With that combination we generally allow from twenty-five to thirty-five square feet of radiating surface to a square foot of heater surface, of pipe coil; and I think that makes an excellent combination heater, and may be made with a single line running immediately around the fire pot of the cast iron furnace, and then brought up about eight inches to a point just above the feed door, and be brought into a spiral, and finally ascend through the centre of the furnace. That gives you better control over the temperature of the hot water than any other, because you can carry a low fire or a high fire. You can bury the lower portion of the coil in the fire, or you can carry a lower fire, so that all this heated surface is merely acted upon by the gases or the radiant heat. And that surface is rated for about thirty to forty square feet of radiating surface per square foot of heating surface.

There are a great many different types of these heaters. But the perfect combination of the two, if that is possible, having a portion of the surface in actual contact with the fire, and a portion of it suspended above the fire, is desirable. If you suspend it all above the fire, when the coal is first put on in the morning and the fire is black on top there is no radiant heat, and there is little heat in the gases, and the water box is chilled; and if a portion of the heating surface is in the fire it is doing its work while the fire is kindling.

Mr. Switzer: In regard to the proportions referred to by Mr. Snow, I would say that I have found, after considerable practice, that those proportions are practically in general use in the most successful systems of combination hot water and hot air heating, and in many sections of the country they are being employed with quite satisfactory success, but in other sections they are absolute failures by reason of the lack of knowledge of the mechanics in charge of the installation as to properly balancing the hot water apparatus, that is, getting the proper proportion of radiation in connection with the capacity of the furnace fire pot and the grate areas, which have all to be taken into consideration. It is a conceded fact that a certain number of pounds of fuel contain a number of units of heat. If they

are absorbed in hot air radiation there is none left for heating the water. The mechanic in charge should be thoroughly informed in regard to balancing up the amount of radiation with the amount of exposed fire surface for a water heater used in connection with hot air.

Mr. Richardson: What would you do with a ring fifteen inches in diameter and three inches in height, a plain ring with cross sections, when you found that if you put it over a 21-inch pot it would do so much work, but that if you put it over a 26-inch pot it would do more than double, at the same rate?

Mr. Switzer: That confirms the statement that experience is necessary to know how to balance up. Any manufacturer that is putting out hot water apparatus in connection with furnace heating should have a variety of sizes of water sections to supply with different types of furnaces. In other words, the size of the water ring in proportion to the fire pot should be so constructed that one balances the other, in proportion to the amount of hot water radiation and warm air circulation required to maintain a uniform temperature in the various rooms to be heated.

TOPIC NO. 5.

"Are all types of sectional cast iron boilers adapted for steam heating?"

DISCUSSION.

Mr. Smith: I think it is pretty safe to say that in any line of goods some things are not so well adapted to their purposes as some others; and probably there are some cast iron boilers on the market, sold for steam boilers, that are not quite so good as they should be. I have had some experience in that connection myself. We designed at one time a steam boiler that would make steam but was not commercially successful. Now, if there are any cast iron steam boilers on the market not doing good work, they will probably be soon retired, though the chances are that they are all of a pretty fair type, and that they do make steam and heat houses.

Professor Kent: I understand that a sectional cast iron boiler is designed for the purpose of raising steam, and I cannot see, if a boiler will make steam at all, why it is not adapted for the

particular use of steam, one at least which requires only a low pressure of steam. We can get our steam from any point whatever. So I say that if a boiler is a boiler, it will do for steam heating.

Captain Reck: In some instances we have hot water boilers and steam boilers after the manner shown in the sketch. When used in that manner, with a large pipe going to the steam drum, and a large pipe going back to the boiler, I think any hot water boiler may be used as a steam boiler.

TOPIC NO. 6.

"Has experience demonstrated the relative superiority of iron or steel pipe as regards durability in heating systems?"

DISCUSSION.

Mr. Barron: No one that I know has any experience that can tell us anything about this. We know about the life of ordinary wrought iron pipe when it is above the ground. I don't know but what its life possibly runs over centuries, if it is properly taken care of. But as to pipe in the ground, I have known where twenty years seemed to be about the period of its life. Where ordinary wrought iron pipe was put in the ground twenty years ago it is about played out to-day. How steel pipe will do under the same circumstances I don't know. It is a problem to-day, when you put steel pipe under ground, either in a trench or right in the earth, it is a problem how long it is going to last, because the structure of steel is a little different from the structure of wrought iron.

Mr. Wolfe: I don't think they have made steel pipe long enough so that the question can be intelligently answered.

Mr. Switzer: I think that is a question for the laboratory when it is installed. It is a question of chemistry regarding the durability of steel and the elements that enter into the constitution of iron. It is a question for the laboratory.

Secretary Mackay: The further you get away from the natural products the worse you seem to fare. Cast iron will last longer than wrought iron, and wrought iron longer than steel. I have had some experience in that respect. I have found that steel tubes have worn out much sooner than wrought iron in the same boilers.

TOPIC NO. 7.

"Has latest practice demonstrated the advisability of using smaller sizes of pipe in hot water heating systems in greenhouses?"

DISCUSSION.

Mr. Chew: That topic was put in this programme because we have never had, as far as I can remember, any discussion of greenhouse heating by the Society, although we have several members interested in it. Unfortunately Mr. Scollay, Mr. John Paine and some of the others who are more identified with that branch of the art are not here to take part in the discussion—unless Professor Carpenter knows something about greenhouse work.

Professor Carpenter: Coming down in the train to-day I had as a companion one of the most experienced men in greenhouse heating, I think, in this country—Professor L. H. Bailey, of Cornell University—and this very topic was brought up. He expressed his opinion from experience with greenhouses heated with large cast iron pipes, in the old way, and also with greenhouses heated with small wrought iron pipes, that for greenhouse work the old cast iron pipes were superior. We have had pretty cold weather at our place. I believe we had the coldest weather on record the morning referred to, it being 21 degrees below zero. In his greenhouse with the large pipe one fire was sufficient for an entire night on account of the large body of water, the pipes having great capacity to hold heat. The result was favorable to his plants; the temperature remained very uniform and there was very little trouble in taking care of the fire. In another house which is in his charge his firemen had to sit up all night to keep the fires going in order to keep the plants from freezing. The large pipe acts in the same way as a large balance wheel on an engine, to preserve the temperature uniform. On the other hand, if the temperature of the water gets down it takes a large amount of fire and a long time to get it hot again. For that particular kind of business where it is not convenient to make fires except at long intervals the large pipe seems to have a special advantage.

Secretary Mackay: Mr. President, I have had experience with four-inch cast iron pipe largely, and also some experience with

the smaller pipes. In fact, I have had such good success from smaller pipes that I have been an advocate of their use, and I think, while Professor Carpenter's statement is correct, that they may have had this trouble there, I have found that it was due more to the depth of the fire box and the capacity of the boiler rather than any defect in the system; that in heating buildings where the temperature gets down to 40 degrees below zero they had better results with two-inch wrought iron pipe than they had ever been able to obtain with the best greenhouse boilers and four-inch cast iron pipes, and I think it is altogether a matter of capacity of the boiler. With sufficient radiating surface in your house, sufficient depth of fire box to hold sufficient fuel to last for twelve hours, the house can maintain a uniform temperature of 60 degrees, with an outside temperature of 40 derees below zero. So I do not think it is the fault of the size of the pipe, but it is the fault of the system or boiler.

Professor Carpenter: I can see very clearly, and I think we all can, how the conditions Mr. Mackay mentioned might be favorable. If we had a very large boiler the results might possibly be just the same as though we had a small boiler and large amount of pipe. To my mind the point is simply this—that for this particular purpose we want a large body of water, and I do not see why it should make any very great difference whether it is in the boiler or in the pipes.

Mr. J. B. Bernhard: I would like to ask Professor Carpenter if there would not be more advantage in having a large boiler and small pipe than to have large pipe and a small boiler, for the reason that we want to keep an even temperature in the houses? Sometimes the thermometer drops very rapidly. They want to get a quick heat. I have been told by greenhouse men that through the day, when the sun is shining brightly, they want very little fire, but sometimes, when it gets towards night, the thermometer drops very rapidly and they want to heat up quickly, and that brought up the question that they preferred steam to hot water just for the reason that they could heat quickly. Would it not be more advantageous to have a big boiler with small pipes, so that they could get up the heat quickly? With the large pipes, as Professor Carpenter says, if the thermometer drops, it would take a long time to get

warm. So I think it would be better to have a large boiler and small pipes.

Professor Carpenter: I think the point raised by the last speaker is a very fair one; it is a fair inference that it might be an advantage, under a good many conditions, to have a heating system aranged in that way. I know in one of our greenhouses at the University we have the heating arranged practically on the plan suggested. Until very recently Professor L. H. Bailey has thought that was the proper method for heating a model greenhouse. But lately, as I have already mentioned, he seems in favor of the old way, with large cast iron pipe, and I merely gave you his statement regarding some recent experiences, without any indorsement of my own.

Mr. Bernhard: Is not this a case where he has got too small a boiler on a small pipe?

Professor Carpenter: No. The boiler is of ample size. He has never had any particular trouble with that. It is a steam heating system, you understand—the greenhouse is heated with steam, not with hot water.

Mr. Harvey: I have noticed out our way, that is around in Michigan, that most of the largest greenhouse owners have entirely dispensed with their hot water plants and are using steam. I have in mind now a plant that I have got considerable to do with. There are six greenhouses, one hundred feet long to the front and six to the rear, with a large central house, about one hundred and forty feet by fifty feet wide. The boiler room is under the whole of the house. It is excavated, with good solid brick walls underneath, twelve feet below the floor, all the floors being on a level, and we have two boilers fifty-four inches in diameter, sixteen feet long, and one is sufficient to do the work, and I adopted the plan of taking one large main down through the center house each way and running the cross main at the further end and supplying the coil at the further end with steam and letting the water of condensation run back to the boiler room. The point that I wish to make is that the greenhouse men say that even in winter, when the sun is shining very brightly, they do not need any artificial heat at all. That is true, and if hot water was used the cooling of that would mean a great loss or waste of heat. Whereas the moment the sun gets down far enough to lose its heat in the greenhouse,

then by turning on the steam instantly they can keep up their temperature, and they find with less coal. Half of these houses had been heated before with hot water, and then this new system was put in, and the difference is very great. I have found by other experiences that steam is more economical for a large plant. On a small plant I believe still that hot water would be more economical. But if you have to carry the heat from the boiler any very large distance I believe it could be carried much more cheaply in the form of steam than it could be in that of hot water.

Secretary Mackay: I understand the topic to refer to whether we should use four-inch cast iron or smaller wrought iron piping in heating greenhouses by hot water. It was not a comparison between hot water and steam, as I understood it. In connection with the size of the boiler I have not found it was necessary to put in a boiler of abnormal size in order to secure results with small pipes. In fact, I stated a case here in a paper two or three years ago where two houses exactly alike, sixteen feet by one hundred, were heated with two different boilers. One was purely a greenhouse boiler, with four-inch cast iron pipes; the other was another make of hot water boiler, with four-inch cast iron pipes and with the interior so reduced by the insertion of a two by two-inch oak strip in the center of them as to reduce the body of water one-half, and the results were 18 per cent. in favor of the boiler with the reduced body of water as against the greenhouse boiler and four-inch cast iron pipes. Both grates were exactly the same, four square feet of grate area, and both had eight hundred square feet of surface on them, but one had four-inch pipe and the other had four-inch pipe reduced to two-inch pipe or a little larger—probably two and a half. Mr. Harvey touches on steam for the same purpose. It is true also in this connection that some of the largest greenhouse men went from what I consider a poor type of hot water boiler, with a single boiler for every house, to one large steam boiler for supplying sixteen houses, but since modern hot water boilers have come out of sufficient capacity they have gone back to the hot water type as being more satisfactory. I had a large case some nine years ago in Long Island City, where there were ten houses, sixteen by one hundred feet. The owner had me design a heating plant for it, but he insisted that he

wanted steam. I said: "You do not want it." He said: "I do. I have seen some elegant working apparatus in Philadelphia, and that is what I want—steam, and one and a quarter inch pipe." He got it. Three years after he took out the apparatus, used the same boilers, changed it over to hot water with two-inch pipes. He has secured a more uniform temperature and a smaller consumption of fuel; the amount I don't know, but he talked something about 25 per cent. less fuel. The only difference between these and Mr. Harvey's house is that these were ten on one side of the pit and none on the other. The two statements do not agree at all as to the economy of fuel. The trouble with greenhouse heating is that in the daytime, as Mr. Bernard has said, they do not require any fires, they bank the fires in the daytime and run them at night, and with a four-inch pipe it holds such a body of heat that it is necessary in order to obtain uniform temperature to open and close the ventilators, whereas with a small pipe they can, by closing the damper reduce the heat without the necessity of opening up the ventilators.

Captain Reck: There is one thing that should be considered, and that is humidity. There is an objection to dropping water down on the plants. There is a great difficulty about that. In Europe the glasses are made double and they take a circulation of air between the two glasses. Then we have in many instances pipes close under the roof. I have seen that you do the same thing. Now the pipes that are placed under the roofs in greenhouses are not cast iron pipes; they would take two much light from the plants, and they would be too heavy, so it is necessary to have smaller pipes there. In many instances in Europe they use cast iron pipes in the same buildings where they use small pipes under the roofs. But I do not see any necessity for this. I endorse the views of Mr. Mackay, that it is possible to get the result as well with small two-inch pipes in the lower part of the houses as in the higher part. As to the capacity of the boiler, it is not the contents of water in the boiler, but it is the fuel capacity. If you have a boiler of large fuel capacity and where the grate is such that it will not be clogged up, then it is quite certain you will have the same fire in the morning as when you left it in the evening. In such cases it is possible to have the pipes as hot in the morning as in the evening. Then I cannot see any objection to having the small pipes in the lower parts.

If you have sudden drops in temperature, as you have in these days, it is much quicker to get the temperature up to what it should be if you have the small pipes.

Mr. Barron: I have not had any recent experience in greenhouse heating. About twenty years ago I was engineer for a concern that made a specialty of it. But my views coincide with Mr. Mackay's. I rather think that a small pipe on the whole is the most satisfactory, although I have no doubt Professor Bailey's experience, as Professor Carpenter relates it, is all right. In a fair experiment, assuming an ideal case and taking equal square feet of heating surface, with a two-inch pipe and a four-inch pipe, I think on the whole the two-inch pipe will prove the most satisfactory to the greenhouse owner. And in relation to steam and hot water, I believe that hot water today, from what little I know of the subject, is on the whole more satisfactory than low pressure steam for ordinary greenhouse work.

Professor Carpenter: Mr. President, if you will allow me to speak again on the subject, we have had considerable experience in greenhouse heating at Cornell University and have made some experiments. The greenhouse for the Horticultural Department was started on a small scale, I think about two hundred feet long by thirty or forty feet wide, and was heated at first with hot water, using the small pipe system. That system was quite satisfactory until it was necessary to enlarge the house, when it proved inadequate and difficult to enlarge satisfactorily. The plant was enlarged to some eight or ten rooms—a number of them very large—and for the enlarged house steam presented many apparent advantages. In order to decide the matter and determine the relative economy of steam or hot water, the house was divided into two parts, one part heated by hot water, the other part heated by steam. The parts were not very similar; the experiment was, however, as fair as possible, and Professor Bailey kept very careful track of the fuel used. I had previously tested two greenhouses, one of which was heated with hot water and one with steam (see Vol. XII, "Transactions American Society Mechanical Engineers"), and in that particular case the hot water heating came out very much better, but in our Cornell test the results were reversed. The steam heated house came out the best; the saving was 15 or 20

per cent. I think it was due to the peculiar conditions, one of which was due to the fact that in the large plant circulation was more difficult to maintain with hot water, especially as the plant was piped. Taking the whole year through, steam gave better economy and more uniform temperature than the hot water. After that experiment a large steam boiler was installed and connected to the whole plant, and it has been heated with steam ever since.

TOPIC NO. 8.

"Has the need been demonstrated of some method of ventilation in connection with accepted systems of heating?"

DISCUSSION.

Mr. Cary: The topic, "Has the need been demonstrated of some method of ventilation in connection with accepted systems of heating?" is not quite clear to me. I do not understand whether this question means, has it been demonstrated experimentally, or whether we have found that it has been needed by our general experience. In answer to the latter way of looking at it, I would say this: Any system of heating is not perfect without some system of ventilation. I recently moved into an apartment in New York where there are large windows and a very poor system of ventilating, and I found that this practice, on cold days, of heating the air in the room and people breathing in it, and heating that air over and over again, was not good and it was not healthy. You would get up in the morning with a headache. I placed a window screen under the window, and did that in several rooms, and I found good fresh air coming into the room all the time, and that there was a much healthier atmosphere. To heat a room or building without ventilation is wrong; there is no doubt about that. And I have found during my experience several laundry plants where that thing has been demonstrated also. I remember the case of a plant in the upper part of the city in which the contractor placed a lot of heating pipes around the side of the room, a small room, and made everything there as tight as a cork in a bottle, and they complained that it took half a day to dry clothes. I studied it over, and then simply put a ventilator in

the upper part of the drying room, and then they dried their clothes very quickly.

We introduced a method of ventilation by which we bring in the air from another place by indirect ventilation. The indirect pipes are in the basement, or somewhere under the room. Of course there is ventilation there, and there is nothing much nicer than such a system, if the whole thing does not freeze. But if you can get plenty of good air in the room, that is a very desirable method of heating, if you could only do away with that undesirable feature. But here we are considering the putting in of our heating pipe right in the room, and shutting it up, with no provision for the fresh air to come in. That is radically wrong.

Mr. Joslin: I think the question No. 8 can very properly be answered "Yes." Going back only a few years, when we had seven, eight or nine story buildings, it was very seldom that you found the first story, when occupied by a bank or trust company, ventilated as well as heated, but I think it would be very hard now to find a building anywhere from five or six to twenty stories high, where the first floors are occupied by a bank or trust company, or by any concern where there are a large number of clerks employed, or in offices of factories, where they do not use ventilation as well as heating. Several cases have been brought to my attention where there are offices and banks on the first floor, heated and ventilated, while the rest of the building would be heated without any means of having ventilation. But sometimes the second floors are both heated and ventilated where years ago they were merely heated. I think the need has been demonstrated, or they would not have done this.

Mr. Frank K. Chew: All the remarks so far have come from men who have spoken in reference to the larger buildings, but we have here quite a number of men who have spent most of their time in furnace work, and also in installing small steam and hot water plants for heating residences. It seems to me that while the big buildings need attention the homes of the people need it most. A few years ago when a man talked of ventilation in connection with the plans for a small house he was looked on almost as a robber. This question, I think, was presented here with the idea of getting some information with

reference to the homes more particularly. A direct plant will work first rate, with ventilation or not, but in indirect heating, steam, hot water, or hot air, you have to get something out to get something else in. That was not as thoroughly recognized a few years ago as it has been lately. Many of the architects in the better classes of buildings make provision for an open fireplace somewhere, whether it has fire in it or not. The fact that the chimney is in the interior of the building, and has a sufficiently high temperature to induce some outward current and enable the outside air to come in, creates ventilation. Now has there been any change that can be detected in different sections of the country indicating a desire on the part of the people for better ventilation in the better classes of houses, and is there any other method than that of the fireplace resorted to? I think the question as I present it can be answered by a number of gentlemen here, and I think the information will be desirable.

Mr. John B. Bernhard: In a case which I had a number of years ago, where there was a hot air furnace, an old Englishman wanted his house tight. He had double windows, and every window and all the doors were battened up, except one side door. He wanted a hot air furnace put in, and he wanted all the cold air taken out of doors, but he didn't want any ventilation. I told him it was impossible to heat his house that way. After three or four days' controversy I finally took the contract, with the understanding that if it didn't work his way I could have my way. We put in a good big furnace and started it going, and in about three days after the furnace had been put in he rushed to the office and said he was freezing at the house. He said that the house was cold, but that the hot air was coming out of the cold air ducts, that it melted the snow outside. In fact, his house was so tight that it produced a pressure high enough to force the hot air back the other way, and he could not heat his house unless he opened one of the windows. I demonstrated to him that if he would open one of the windows he could heat his house thoroughly, but he didn't want it that way, and we cut a register in the floor and attached it to the cold air, and in twenty minutes from the time the hole was cut in the floor, without any change in the fire in the furnace, the thermometer went up fifteen degrees.

Mr. Joslin: Does the gentleman consider that ventilation?

Mr. Bernhard: No, but it shows that you could not heat a house without circulation.

Mr. E. E. Berry: It seems to me there is a lot of difference between circulation and ventilation, though many people seem to think that circulation is ventilation, especially the public. I had a case recently in the northern part of the State, where a school committee wrote to us and said that they had a primary schoolroom which was nicely heated, but that it was not very well ventilated. It contained about nine or ten thousand cubic feet of air space, and they had a ventilating pipe three by ten inches, and wondered if it was large enough. And I think the case of the laundry that has been mentioned demonstrates clearly the fact that circulation does not change the air in the room. I had a case also in Niagara Falls a short time ago. There they use electric power a great deal. There was a firm manufacturing woodwork for interior finishing, and their dry kiln was heated by a warm air furnace. They had no exhaust steam which they could use, and for a number of years they had been unable to get the kiln to dry at all; the lumber didn't get dry. If the plant had been placed by a man familiar with steam heat drying kilns, he would have supplied a ventilator shaft. Simply passing the air through a room and sucking up the moisture does not dispose of it.

Mr. C. M. Lyman: As to the practice in the northern part of New York and in Vermont, I have noticed that the people there are more anxious to save fuel than to have an abundance of ventilation. But there is one phase of this subject that has hardly been touched upon. Take an ordinary house having from eight to ten or twelve rooms, occupied by a family of only four or five persons and provided with one fireplace, and without double doors, and everything all battened up, with the amount of circulation which will take place simply through the cracks and around the windows, I seriously doubt whether such a house would be looked upon as well ventilated. Yet in the northern sections of the country, with air inside at a temperature of 70 degrees, and the air outside down to from zero to 40 below, there really would be circulation enough through cracks and walls to supply plenty of ventilation for the average home, I think.

Mr. Cary: As to the matter of ventilating homes, I have looked into this subject considerably. Having the trouble in this apartment that I have spoken of, the first thing I thought of as about the only thing to be done, was window ventilation. I know that the air in the rooms where they have these window ventilators is very much better than it was before, and in fact is very satisfactory.

(The speaker illustrated his remarks by means of a sketch on the blackboard.)

I have tried to illustrate here in a very crude way the lower and upper sash of a window. The lower sash of the window was raised, and this board placed underneath, which fills the entire space, carrying the ventilating apparatus. The lower sash is raised higher than the bottom of the top sash, and is closed at this point by a strip of rubber about one-quarter of an inch thick, which makes a joint which is tight enough. In this lower board an opening is cut through from the outside of the window into the room. In the room is an upturned end or spout, the air coming into the room in this way. The air, of course, must be blown into the outside of this opening, and in order to secure a positive blast of air, there is placed a very ingenious little triangular strip, which swings on a pivot at the central point, and as the wind blows in this direction, it will blow in and open this and the wind will blow into the room. I have experimented with tobacco smoke and found that sometimes the wind would close this little slat on the outside, and the wind would pass through the box in which this slat is enclosed, and would draw the tobacco smoke out, showing that at times the wind was blowing into the room, and at other times it was being drawn out of the room. It was a very simple device, and it has proved very effective in my case; and I think we will have to resort in a good many private houses, where they cannot put in expensive ventilating apparatus, to some form of window ventilation. Probably the simplest form of window ventilation is to take simply a board and place it under the lower sash, raise the sash, then shut it down, and leave a small opening between the upper and the lower sash, and the air will come into the room through this opening here without causing a draft. Ordinarily, if you have any curtains, the curtains will flap very badly, but with this device it throws the air

out into the room and there is no trouble with the curtain. It has proved very satisfactory, and I have got very good results.

Mr. Barron: I would like to say a word more. In a work published in England twenty years ago this subject was gone into very fully, and it seems to be forgotten by everybody that all we know is simply that there is a certain throat area of the occupants of a room and a corresponding flue area in the wall that will give sufficient ventilation to sustain life, and the heat of the body will create a current as long as there is an inlet for the air corresponding to the egress. But the position taken by architects is that they cannot provide space in the wall for ventilating flues. You tell them that if the room is to be occupied by one person they can have a small flue, and that the flue must be larger if it is to be occupied by more persons. But they say they cannot provide that flue area in the building, but, as a matter of fact, if we were fully civilized, no man would attempt to build a structure of any kind in which he would not provide an outlet for air of sufficient area for the number of people who were going to occupy the place. There should be an area sufficient for the air exuded by the lungs to go out of that space which is going to be occupied. If in the Black Hole of Calcutta there had been a ventilating area corresponding to the area of all the throats of the people confined in that Black Hole, there would have been no deaths there. The heat from their bodies would have produced a current enough to have produced the proper ventilation. But that is an elementary fact that you cannot get into the minds of the mass of architects and the mass of laymen. You cannot get it into their heads that every building should have a flue in the wall corresponding to each room of the building. The New York Building Laws compel builders to put in windows. But in addition to that it should be provided that when the window is closed there should be an opening going to the roof of the building to carry off the air exuded from the lungs of the occupants.

Mr. Chew: It has come under my notice at different times that the utilization of the heat in smoke pipes has been resorted to for inducing exhaust currents from rooms in small houses, not the larger ones. It is only a question of dollars and cents apparently. But unless the people themselves ask the man who

installs the plant about this matter, he is not likely to make himself additional trouble by telling them about it. There are in this section of the country many houses where small pipes, not connected with the smoke flue, carry air that sometimes passes over the top of a hot air furnace, sometimes over the top of a steam or hot water heater, and the air that comes to this point is heated sufficiently to carry it over to and up the vent flue. These little conductor pipes, about three or four inches in diameter, lead from all sides of the building for ventilation purposes. Here and there some fellow has had the courage to bring it to the attention of a customer. And this question as here propounded is, Has the time arrived? Has the need been demonstrated? Well, of course, that is like all other topics, is to bring out discussion. You may answer, yes, or you may say emphatically, no, the people are not ready for it. There are few architects or heat contractors doing business in New York who can say to a customer, "You want your house ventilated." The majority of the houses are built for people who have not asked for ventilation.

Mr. Cary: The matter Mr. Chew brought up reminds me of an experience I had in the city. A friend living in the upper part of New York had a bathroom built on the top of an extension on a level with the second story of his house. The plumbing connections were not right and the result was that there was a good deal of backing of foul water and foul odors in that room, and it gave him a good deal of trouble. They had no connections for heating. They put in one of these small gas heaters or radiators in the room, and had a good deal of trouble heating it. Finally they made up their minds they did not want to imperil the lives of their family by using that bathroom and they closed it. I looked at it and overcame the difficulty very easily by running a pipe like a stovepipe above the roof, and I covered it with a non-conducting covering. In the base of that smokestack I put a gas burner which was sufficient to heat the air in that little chimney and create a current. Then they thought, "We have had trouble with heating this room before, we could not heat it before, and you have punched this hole into the outside air, and we shall have more trouble still." They were surprised to find that they could heat the room quicker. The troublesome odors dis-

appeared, and the air was in circulation all the time, and the air heated near the heater was carried out through the room and to the opposite side and discharged, and the whole trouble was done away with. There are a number of simple devices of that kind that can be used. But the trouble is that in many cases they do not seem to understand that it is necessary to establish a flow of air. They want some kind of aspirator that will draw it up, whereas that can be established by putting a set of pipes in a flue and connecting small pipes with it, or by placing a gas burner at the foot of the stack.

Captain Andrus B. Reck: If you will take my English as it is I will tell you a little about how the thing is done in Denmark. We have assistance from doctors in Denmark. The doctors are going into all the new buildings, and very often they find that the air is very bad. You will understand that when people build houses, not for themselves, but to sell to others, they are interested in making things as cheap as possible, and I don't think we can interest that kind of people in making ventilation, if they are not directed to do so. But the doctors in Copenhagen very often write in journals about bad ventilation in the new buildings, and the result has been that there is now a new construction for buildings under consideration in our country, and in each new house that is to be built there must be such ventilating flues that there shall be an outlet for bad air from every room in the house. We have seen that in most cases it gives no good results if you take the air directly from the outside, because people stop the openings; they close the openings that give them drafts in the rooms; so there must be a device to introduce the air that is not open to that objection. My opinion is that if you ventilate the halls in a house very well, then you have an easy means to get air introduced in the rooms, when you have ventilators to take the air out of the rooms. If, as in England and in your country, there is a chimney, that is the best opening you can have, only I think there must be always an opening at the ceiling. I recollect that in my own house somebody left a lamp burning in the hall too high in the evening, and during the night the black that comes from such a lamp went into all the rooms in the whole house. We did not find a room where there was no black, and the doors were closed throughout. That shows that even

if you cannot see openings very much air comes from the hall into all the rooms, if you only have suction from the rooms—at least in Copenhagen. In Copenhagen, in the upper apartments of the building, when you have a staircase, and no ventilation of that staircase, the bad air that comes from the hall goes into the upper floors. I think there should be some directions given that there should be air introduced in the halls and staircases of a private residence. I am not speaking of schools and hospitals and public buildings. Everybody knows that there should be ventilation there. But in private buildings, I can say that the experience of Denmark comes to this: If we ventilate the halls and introduce a good deal of fresh air into the halls, there is always air passing through, and if you have openings into all the rooms, I think you will find that no home will be without ventilation; and you need not fear that people will go and stop those openings from the outside.

Mr. A. E. Kenrick: I would like to ask Mr. Chew four questions:

First. Would you recommend using the smokestack of the hot air furnace for heating the aspirator shaft?

Second. Is that an economical way of heating the aspirator shaft?

Third. What would be the effect on a well-regulated furnace of using the smoke pipe for heating the aspirator shaft?

Fourth. Should not, in every well-constructed and well-regulated furnace, the smoke draft be perfectly cold when the fire is sufficiently kindled?

Mr. Blackmore: This is a very interesting discussion, and yet it seems to me rather strange in the tenth year of this organization that such a question need be asked. The very fact that want of ventilation was a great evil brought about the organization of this Society. The mere fact that we have found it necessary to ventilate our schools and public buildings points very strongly towards the fact that ventilation is necessary. If necessary on a large scale, it is necessary on a small scale. Again, if you have paid any attention to the medical journals recently, you will have found that fresh air, outside, open air exercise, is getting to be regarded as the most beneficial method of curing consumption and a great many other diseases. Why is this? Is it not due to the recognition of the difference in the

air between the outside and the inside of the building? These things we read about in the papers, but they are passed over without proper thought; whereas, if we sit down to think a few minutes, we should find that ventilation makes the difference. Mr. Barron, with his usual happy facility of expression, has coined a phrase "throat capacity." That is a very good phrase. The only trouble is that it is a variable quantity. Some throats have a great deal more capacity than others, especially among the manufacturing fraternity. But that leads to a point that I wanted to bring up, and that is, that the difference in the throat capacity makes it necessary to adopt some standard for ventilating. We have adopted a standard for schools and public buildings, and it seems to me it would not be a bad idea to turn to our Committee on Standards to work out that problem. I know that data on this subject would be invaluable to architects. Mr. Barron says that architects object to the size of the flues. They do, but there is no doubt that the architect could be educated up to the necessity of proper provisions for any standard that our Society would recommend. It is a function of this Society to devise a standard that could be adopted for the house and give reasons why the standard is necessary. While our friends the hot air men can no doubt tell us a great many ways of getting rid of foul air, we need not touch upon that point. We as engineers should ascertain what is necessary to produce good results. Ideal results we cannot hope to get at present; later in the century we may. But good results can be had, and they can be had within reasonable limits, and if those were defined the architectural fraternity would take them up.

Mr. Chew: I should be glad to second the motion if Mr. Blackmore would make his suggestion in the form of a motion, to refer that to the Committee on Standards. In the meantime I think I can give a little information to Mr. Kenrick. In the first place, the one reason possibly why some of these systems which have come under my notice have not been pushed is because of the effect that they have had. The effect of cooling the smoke is in the experience of almost everybody. There are drums and smoke pipes all through the country. They utilize the heat there. If you can utilize the heat from the smoke of an ordinary kitchen stove, that is all the heat you

require to introduce quite a bit of ventilation, because I don't think it is necessary to have great ventilating flues. I have had the good fortune to see residences where a little flue connected with three-inch pipe would take out air enough all the time to induce a good inflow from hot air furnace pipes that might otherwise hang fire a little. I know of one case where a man used the smoke pipe from the steam boiler for the same purpose. He enveloped his pipe in a long cylinder and brought the little exhaust pipes from a dozen different rooms to that cylinder, and connected it with a flue along the smoke flue. As to the other question, I will say that I visited a friend once who led me to the smoke pipe and said, "Put your hands on the smoke pipe." I did so. He said: "This is the only apparatus in this neighborhood where you can put your hand on the smoke pipe." The check draft was wide open and the smoke pipe was cold. And the smoke pipe can be used by means of the check draft to carry off air for ventilation if it is only connected properly. A man in Camden, New Jersey, has an apparatus down in the basement below his office which was about fifteen or eighteen feet square, and he exhausted air for ventilation by means of the check draft of his furnace. He had wire connections made with levers attached. When he wanted to ventilate more he pulled his levers one way. If he wanted less ventilation he turned them the other way. It did not kill the operation of this apparatus to utilize the check drafts for ventilation, but it is only here and there that you see it done. People are not sufficiently interested in the subject. The man who is selling a furnace or a hot water boiler has trouble enough, and he is not hunting up the job of putting fresh air into the house.

Mr. Bernhard: I think some years ago a system was patented in which a register was placed in a hall or living room on the first floor, and a pipe conducted down which operated on the check draft in the furnace. By opening this register you check your furnace, just as you would check a furnace now by opening the check draft in the cellar, but by exhausting the air from the living room you introduced a system of ventilation. Whether the patent has expired or not I am not sure. But it seems to me that it is open to the objection that there is always the liability of a back draft, and at times there would be danger

in such a contrivance as that of gas coming into the rooms.

Mr. Chew: You are pretty sure of your gas anyhow.

Mr. Cary: I have a friend in this city who is a mechanical engineer, who has retired from business. He built a house on Seventy-fourth Street, and he had plenty of time to give ample thought to all the requirements for designing the house properly. In designing the house, instead of taking up every square foot of surface for living rooms or other conveniences, he left a shaft from the basement to the roof and placed a skylight over that. He brought the smokestack from his furnace—he has a steam boiler—up through this central shaft located in the center of the house. All his steam pipes and risers came up through this central shaft, so that there was always plenty of warm air collected in this shaft. There was always a rising current of air. This was so located in the center of the house that ventilators opened into it from each floor, and he took a great deal of pride in blowing tobacco smoke there and showing how it would ascend. From the rooms at both the street end and the rear end of the house the air is always passing towards this central shaft, and he has established ventilation in a very simple way. It simply amounts to giving up a certain part of the floor space all through the house vertically, and putting in a shaft, and thus you get a very good system of ventilation. His house is certainly a well-ventilated house, and it would be pretty hard to improve on that for a private house. That suggestion might be adopted by others. As to the matter of cooling the furnace gases ascending in the chimney, that is done when you want to check your fire. You can open or close your check draft and regulate your fire in that way. The regulation is simply due to cooling the column of air in this chimney. As you cool your column of air you increase its density, and you decrease the rapidity of its flow. Now that must not be checked so much, it must not be so tied up to other systems, as to interfere with the perfect working of your furnace. Sometimes you want your check draft closed in very cold weather. Then, if your house is entirely closed and your windows and doors are closed, and you are getting no drafts, you are having no foul air from your rooms and throughout your house drawn up into the chimney and sent up in this way, and that is just the time when you need it most. To interfere with

that check draft by tying it up to any other system is somewhat dangerous. The whole combustion in your furnace depends upon the rapidity of the flow of the gases, the hot air and gases, as they pass up. That must not be interfered with, if you want to get good combustion.

Mr. Cary: Those heat units in your coal you cannot develop unless you get enough air through your coal in order to burn it thoroughly. With our coal partially burned we may get a furnace efficiency or 30 or 40 per cent., whereas we should get a furnace efficiency of nearly 80 or 90 per cent. if the coal were thoroughly burned. You must supply an ample amount of air through the furnace to get an efficient furnace, and that means small coal consumption for the amount of work done.

Mr. Hosford: I think we ought to recognize in the fact that so many houses are heated by indirect methods that we are getting ventilation. We recognize, as some member has said, that you cannot put three quarts into a two-quart bottle, and all the air that comes through your indirect method, whether over a furnace or over a stack of indirect radiators, cannot come into a room unless it replaces an equal amount of air that is withdrawn; and there are hundreds and thousands of cottages being heated by furnaces successfully where the air is taken entirely from the outside. And that air is removed in some mysterious way from the house. It is a question sometimes where it goes out, but we know that it goes out, and we know that a sufficient quantity comes in to keep the house at 70 degrees. I think that is ventilating that house. I am not looking for ideal conditions, but we are getting the most practical results. I had an experience two or three years ago with a large private house of forty or fifty rooms. They insisted strenuously that all the rooms should be heated by indirect hot water, and you know what that means. I found, on looking over the building, which was being remodeled, that it had provision for four large furnaces. I found that there were ten bathrooms in that house, most of them six by ten or eight by ten, none larger than ten by ten, and I made the proposition that I thought it would be impossible to heat those by the indirect method, and submitted plans for direct radiation for all those rooms. But that was turned down, and they insisted that I should do it by the indirect method, and with fear and trembling I did that. There

were in the main rooms of the house, largely downstairs, but one or two upstairs, fireplaces. This system has been in use now for the third winter, and it is successfully heated, and I claim that the fact that the house is successfully heated implies that it is successfully ventilated, because no more air can come in than goes out. My own thought on the subject of an ordinary private house of eight or ten rooms is that in a house with one good, large fireplace downstairs and a good indirect radiator heating the hall that would supply all the air the family may require. It may not be capable of furnishing thirty or forty cubic feet of air for each person, but I think it is very good.

A good deal has been said about introducing air through the windows. But I think that you, heating and ventilating engineers, who contemplate bringing in fresh air into a room in connection with some heating system are belittling your own profession. I think we ought to heat our air before we bring it into the room. The other way is a makeshift. Another trouble, I think, is that people think they must ventilate at the ceiling, but how often have they been defeated in churches? With a ventilator at the top in the ceiling, which will take the heat, you know how long it takes to heat the place.

Mr. Kenrick: I would ask the gentleman if he ever experimented by means of an anemometer on one of these registers, and if he didn't find two currents, one upward and one downward?

Mr. Hosford: No.

Mr. Cary: We get on dangerous ground if we take that position. It is very true that with an indirect system the cold air coming in will displace the other air in the house. The air which is displaced, of course, finds its way through window cracks, door cracks, and there is, especially in a frame building, a great deal of infiltration of air going on. We know that, because the weather strip man's business would not be quite so good if it were not so; and we are getting now to be well up in weather strip appliances, and we are putting more of them on, and we are losing that much ventilation. Another thing, window jambs, door frames, and everything of that kind are being made much more perfectly than some time ago. Take a house some ten years old, and by the indirect system you get plenty

of ventilation. The fresh air coming in will force the other air out, but as the houses are being built better, and as we are preventing infiltration or outfiltration, if I may coin a word, with weather strips and other appliances of that kind, the demand for good ventilation is becoming more and more imperative with the indirect system.

Mr. Chew: Gentlemen, I am voicing a suggestion that comes to me through the President, but I will present it in my own way. One reason why hot air furnaces have been looked on as something of an evil is because to accomplish the desired results the air is heated so hot in many instances it is almost a blaze that comes out of the register. Now that is necessary to heat the building. Why? Because there is no provision for that air in that building to get out. And the question arises, How much does it cost to ventilate the house? The excessive burning of fuel and the excessive high temperature at which it is necessary to have the air delivered, is due to the fact that there is no provision for the cooled air to get out. One day, when the thermometer was below zero in the cold air supply duct to the plant in a Philadelphia office, water was boiled in a new tin cup that held about a pint, with nothing but a sheet of paper over it, on a register twelve feet from the furnace. If you talk to a man about installing a ventilating plant in his house he says no, but he will burn an excessive amount of coal year in and year out to heat his house, and yet he does not know that he is paying for ventilation, and paying rather liberally for it, without getting it. The small cost of a ventilaing system would soon be paid for by the coal saved.

Mr. Bernhard: I have known a case very recently where one contractor uses an electric fan to aid ventilation or to aid the movement of the air in the house. That is in Detroit. It is his custom there, in the cold air duct, which generally comes from out of doors in that city, or in the ventilating shaft, to put a common electric fan twelve or fifteen inches in diameter; and that is wired to a push button in the hall, or some first floor room; and at any time in the day, when the occupants feel that the air is not circulating rapidly enough, by pressing that button they get an increase in the amount of air coming through the heater. I believe that if this Society would adopt some standard, however low, for ventilation, the contractors

would go to the architects and say: "We want some ventila ion. This is the standard. Give us half of this, or something." And they would do so.

Mr. Cary: There are different methods for ventilating and the Committee on Standards would have a pretty difficult proposition to deal with in order to establish a standard method of ventilating houses. A system which would apply to one class of houses would not apply to another class. I would suggest that rather than attempt to establish a standard they should collect data on this subject of the various simple methods that have been in use, and offer them as various suggestions for ventilating houses. That might be offered as something which had been properly studied by this Society. And we could go before the public and say: "Here are a number of different ways of accomplishing this result of ventilating houses and getting better air, and a more uniform and constant heat, and you can look them over. Some of them will probably apply to the proposition before you." It seems to me that if such suggestions were offered it would be a good deal better than trying to establish some standard for the public.

Captain Reck: We have had a great deal of experience with electrical fans in Denmark, and I think that at all times the use of electrical fans is better than using shafts, chimneys or steam pipes, mostly because we have the same ventilation in summer time, when we use the electrical fan, as in winter, and we need the ventilation as much in summer as in winter.

Mr. Kenrick: Mr. Chew said that he boiled water on a register. I think the great trouble with the hot air system is simply the lack of cold air supply.

Mr. Chew: The register was within ten feet of the front door where the water was boiled. There was no trouble at all about holding a match over that and the thing taking fire.

TOPIC NO. 9.

"In making screwed joints is it better to use some compound or make them up iron to iron with no compound?"

DISCUSSION.

Mr. Hugh J. Barron: The practice in New York, very largely, is to make joints iron to iron, not to use red lead or any of the various compounds that have been gotten up for the purpose.

But recently, on high pressure work, many engineers have found that compounds seem to have some advantage, and there are two or three parties who are introducing compounds for that purpose, putting them up in packages and selling them and advocating their introduction. I think, therefore, it is a topic that will have to be discussed by those who are using anything of the kind. As far as my own practice goes, it is exceptional to use anything; we use metal to metal. But I know there are others whose practice is different. And very often you find a workman who is not satisfied unless he is using red lead or a mineral compound of some sort. I know that machinists and plumbers generally use red lead. In the old days of pipe fitting nobody would think of putting up pipe with joints without putting something on the joints.

Mr. Cary: I quite agree with Mr. Barron that metal to metal joints are much preferable. But I have had more or less experience with piping lately, and I find there is a lot of bad piping on the market. It is almost impossible sometimes to make up joints without using some kind of "dope" as it is called. I don't believe in it, and wherever I can find an opportunity to specify that the joints shall be metal to metal I do so, and I have a great deal of high pressure steam fitting work. The use of linseed oil, mixed into a thin paste with plumbago or graphite, I think makes a very good joint. I have had excellent results from it. If a joint has ever to be taken apart again, it can generally be broken easily. It helps to fill up a little bit and makes it somewhat easier than putting it metal to metal; and in screwing the pipe up you have a little lubrication there, and you are able to set up your pipe more solidly than when no lubrication is used. A little oil should be used anyway, even if it is a metal to metal joint. Another reason for using compounds is to avoid a trouble which is also very common, that of bad thread work. But if we can specify and insist upon its being carried out, metal to metal work, using a little oil and a little plumbago, we know that will give us a good job. If some kind of compound has to be used to make a job that will pass inspection, the probabilities are that there is bad pipe cutting, bad threading, or bad material used in the pipe.

Mr. Kenrick: That seems to be my difficulty. I have seen a great variation in fittings made by the same concern and

made in one lot of fittings. To-day you set your adjustable die so as to get a good, clean thread, and a good fit; to-morrow a fitting comes from the same concern, and you can almost run it right up by hand. There is a variation in their tools, and a great variation between the fittings, as well as in pipe coming from different manufacturers.

Mr. C. M. Lyman: I would like to ask Mr. Cary if in making up a fitting with linseed oil it is not really a "dope"? If made with lard oil, or a simple lubricant, it would be different, but is not there a little of the nature of stickiness in the other, which helps to make the joint tight? In relation to the question of tapping fittings, I think a good many who have had experience with radiators have found that often the bushings are tapped so carelessly that it is almost impossible to make up a tight joint. The taps that are used on the drills seem to run so hard at times that it is almost impossible, unless something is used, to make up a tight joint.

Mr. Cary: Linseed oil in connection with graphite seems to be a little better than some other oils to mix up the graphite, and it seems to hold the graphite in position better than lard oil or other oil. I agree with the gentleman that linseed oil may be in the nature of a compound or "dope." But, as regards the matter of tapping out the various fittings, I have had some experience in that line. The great trouble with most of the drill work, where the drilling is done by machinery, is that the tap is held rigidly in the holder. Where that is the case, if the holder runs out a little bit it is going to make a larger hole. I have overcome this trouble by allowing the spindle to run loosely and let the tap find its own center. But, when the tap is held rigidly in the spindle, you are going to ring out that hole larger, if there is any obstruction, and if everything does not run perfectly true.

Mr. Andrew G. Paul: My experience a number of years ago, when I was in the valve business, was that we had to change entirely from the general standard on tapping a valve; and on some sizes, if I remember correctly, we had to taper three-quarters of an inch to the foot. If we did not do that, the pipe would bottom on the seat of the valve in some cases, and in other cases the pipe would not go into the valve at all. We had both kinds of complaints, and we were obliged to make the

taper in the valves so great that the pipe would go in but the end would not go down to the seat. That is the way we overcame the difficulty and were able to sell our valves.

Mr. Kenrick: I think the greatest trouble in using compounds is the manner in which they are used. Instead of putting the compound on the inside, on the female end of the fitting, they put it on the male end, while on the female end it is allowed to roll along and accumulate material, more so with graphite than with red lead.

Mr. Cary: Graphite should be put on with the consistency, say, of ordinary soft butter or like the sweet oil on a table, very thin, and painted on. The only trouble in putting compounds in the female side of the pipe fitting is that as you put the male in, it has a tendency to force the compound in front of it and roll it over in front of the pipe, so as to stop the opening of the pipe. You are apt to accumulate that material as you screw your pipe in, which is undesirable, of course.

Mr. Barron: Before we pass this subject, I would like you, Mr. President, to give us the practice of Cincinnati and the Middle West, as far as you are familiar with it, particularly in high pressure work.

The President: We have used red lead. We have the old style of fitting, but we are very careful to place it on the thread instead of in the thread, where all of it will have to be pushed out. We find that in disconnecting some sort of lubricant should be used, otherwise our pipes become rusted in so that we cannot back them out. In flange work, such as ground flange work for high pressure work, we use a graphite with a little boiled linseed oil of the consistency of table oil. We place that on our flange, with the idea of allowing it to come out freely. We also paint our gaskets with graphite and oil for the same purpose in our flange work. In power plants we have a graphite oiling system, where the tank is placed at thirty or forty feet higher than the engine and the cylinder, and lubricant journal oils are pumped into the tank above, and then down through into the cups, and back again from the journals into a filter. We make those joints with black asphaltum. We take the black asphaltum and let it become like soft butter; we then place it on the thread and screw it into our pipe. Our experience has been that red lead placed on the joints in an oiling

system will not hold the oil. They will leak. We discovered, through the suggestion of a Chicago steam fitter, one of the men that we had employed, that black asphaltum would meet the purpose, and we have used it ever since. We find that some sort of lubricant mixed with either graphite or red lead is necessary, first, because the fittings are not tapped right. A great many of the threads that we cut on this so-called semi-steel or semi-iron pipe, or soft steel pipe, strip—not exactly strip—but the threads are imperfectly placed in it. The pipe may look perfect on the face, but when you cut in with a new tool there will be little marks in through it. We have to provide something in the way of red lead to make those joints tight. We follow along in that line, and we have no trouble, but we have to watch the steam fitter very closely. He has the greatest tendency to take a brush and run it around on the inside of the fitting, and the foreman and superintendent, and every one who visits the job, including myself, have instructions to always stop it, but the next day you catch him doing the very same thing again.

Mr. Barron: Then I would like to hear from Mr. Joslin. He has had experience with pipes that ought to be very tight.

Mr. Joslin: I have not had experience in pipe work for a great many years, and then only in running small pipes. We also used black asphaltum upon those. But I have listened to the discussion with interest, and I think the great trouble is on account of the steam fitters putting so much red lead or lubricants upon the threads. A very little is a great deal better than a great deal. When you screw pipe into a fitting, if you have a lot of lubricant on it, it forces it forward in the fitting, and eventually it lodges in some pocket and fills and clogs up the pipes. But there is one feature that has not been spoken of today. We have talked upon the question of screwing the pipes into the fittings, but nothing has been said about screwing them into the couplings. When you screw into fittings you screw into cast iron usually. In screwing into wrought iron it is somewhat different. A great many joints leak in the couplings as often as they do in the cast iron fittings themselves.

Mr. Cary: Boiled linseed oil and graphite is a good thing to use in either wrought iron or cast iron. If there were only more specifications drawn and more people insisting upon joints being made up without the use of red lead, or any of these other

compounds, with nothing more than oil or some very thin lubricant, that might be a means to the end that we all desire to reach. We are getting an awful lot of bad piping. Mr. Joslin, speaking of couplings, has reminded me of a good deal of trouble that we have had with a job lately, in which we have found a good many split couplings. They split or open as soon as you get your steam on. There should be something done to stop this bad pipe work. We should have pipes on which we can cut a good, clean thread, and if we can suppress the use of so much of this compound or "dope" that we see them use, we may be able to get it. They may kick a little, those that are furnishing the pipe, but that may lead in the end to our getting better material.

Mr. Kenrick: There is another great evil. There should be a standard, and a recognized standard, in regard to the length of the thread. Take a factory die, and you will find it cuts from one-eighth to one-quarter of an inch longer than the ordinary die, and that makes a great difference. I think the time has come when the old-fashioned solid die should be abandoned, and when everybody should use the adjustable die. I think there should be at least two, if not three, threads remaining outside of the fitting after it becomes pactically tight. If you cut your threads and your threads go out of sight in the fitting, then the very next turn snap goes your fitting!

Mr. Joslin: The nature of our business militates considerably against our getting a perfect joint, for one reason, and that is that if we could have the pipe and the fittings as they come from the manufacturers, and put in immediately at the time they arrive at the building, when the thread is fresh upon both, and they are not covered up with dirt, mortar, lime and so forth, I don't think we would have to use anything but plain oil, just to lubricate the thread in going into the fitting. When the pipe is dumped outside of the building to-day it is covered with slush and mortar, and the fitting is the same way, and we have to use something in order for the thread to enter these fittings properly. Sometimes a pipe falls down and jams the thread, and if the steamfitter is not careful in looking at it he puts on a little red lead, or considerable, or other lubricant, and lets it go at that. But if we were able to take the fitting the minute it came from the manufacturer and put it together I don't think we would have to use anything.

XUM

Members and guests registered at the Tenth Annual Meeting.

MEMBERS.

Homer Addams,	E. J. Febrey,	E. S. Mobley,
N. P. Andrus,	Aug. Geiger,	C. E. Oldacre,
H. L. Anness,	H. B. Gombers,	M. P. Osbourn,
H. J. Barron,	J. A. Goodrich,	A. G. Paul,
Thos. Barwick,	Richard Hankin,	A. B. Reck,
J. B. Bernhard,	A. Harvey,	H. H. Ritter,
J. J. Blackmore,	T. G. Haywood,	G. A. Robertson,
F. P. Blodgett,	John Hopson,	John P. Schaffer,
E. J. Brooks,	S. A. Jellett,	O. Schlemmer,
Robt. Campbell,	H. A. Joslin,	U. G. Scollay,
E. F. Capron,	A. E. Kenrick,	P. H. Seward,
R. C. Carpenter,	Wm. Kent,	L. B. Sherman,
R.R.M.Carpenter,	J. H. Kinealy,	H. A. Smith,
B. H. Carpenter,	J. G. Klemm, Jr.	Wm. G. Snow,
A. A. Cary,	C. M. Lyman,	C. B. J. Snyder,
F. K. Chew,	Jas. Mackay,	E. P. Sparrow,
G. W. Clark,	W. M. Mackay,	B. F. Stangland,
S. G. Clark,	H. C. Mallory,	W. R. Stockwell,
F. J. Corbett,	A. S. Mappett,	Wm. H. Switzer,
H. D. Crane,	H. S. Martin,	R. B. Talcott,
A. A. Cryer,	F. G. McCann,	C. Teran,
Jas. H. Davis,	W. H. McKiever,	C. P. Vanderveer,
F. A. Dwyer,	F. C. McLain,	Wm. C. Vrooman,
A. C. Edgar,	F. M. Mechling,	E. P. Waggoner,
Geo. B. England,	Geo. Mehring,	Warren Webster.
A. M. Feldman,	H. C. Meyer,	W. F. Wolfe,

GUESTS.

Geo. M. Aylesworth, M.D.,	F. C. Bradbury,	R. G. Davis,
	R. F. Furns,	H. M. Devoe,
E. C. Baldwin,	H. D. Carter,	W. J. Dewitt,
E. S. Ferry,	H. Colwell,	G. F. Downe,

W. H. Driscoll,
F. C. Ekfeldt,
T. C. Fleming,
Jos. Graham,
R. E. Hall,
T. F. Hanley.
F. W. Herendeen,
A. S. W. Hoffman,
J. C. Hosford,
B. H. Hurd,
J. G. James,
C. V. Kerr,
W. A. Landau,
J. J. Lawlor,
H. B. Lyman,
W. W. Macon,
C. J. Mahoney,
J. G. Mayer,
G. G. McDuff,
C. A. Miller,
L. J. Mueller, Jr.
H. W. Nowell,
A. J. O'Neill,
E. Schlemmer,
H. Sloan,
P. H. Smith,
R. J. Sovereign,
R. Stewart,
Leonard Tapley,
J. H. Tethorins,
T. Webster,
F. E. Whitesell,
L. H. Whulus,

TRANSACTIONS

OF THE

SEVENTH SEMI-ANNUAL MEETING

Detroit, Mich., July 15, 16, 1904.

XUM

CXXIX.

PROCEEDINGS OF THE SUMMER MEETING.

The seventh semi-annual meeting of the American Society of Heating and Ventilating Engineers was held at the Hotel Cadillac, Detroit, Mich., on July 15 and 16, 1904.

The first session was called to order at 10.05 A.M. on July 15th by President Andrew Harvey.

The Secretary called the roll and announced to the chair that a quorum was present.

The Secretary announced that the following persons had been elected to membership in the Society since the last meeting:

NEWLY ELECTED MEMBERS, DETROIT MEETING.

EDWARD S. BERRY,	Philadelphia, Pa.,	Member.
CLIFFORD R. BRADBURY,	Washington, D. C.,	"
JOHN S. BRENNAN,	Milwaukee, Wis.,	"
LOUIS COURTOT,	Dole (Jura), France,	"
WM. H. DRISCOLL,	Jersey City, N. J.,	"
OLIVER MILLER,	Warrensburg, Mo.,	"
EDWARD K. MUNROE,	Baltimore, Md.,	"
AMBROSE O. NEAL,	New York,	"
HERBERT W. NOWELL,	New York,	"
ALEX. ZECK,	Grafton, W. Va.,	"
HOWARD T. GATES,	New York,	Associate.
EDMUND SCHLEMMER,	Cincinnati, O.,	Junior.

The President: Gentlemen, His Honor, the Mayor of Detroit, had kindly arranged to come here this morning, but was unavoidably called away. There is one thing, however, that our Mayor has the faculty of doing, and that is of putting the right man in the right place, and he has requested a gentleman who is fully qualified in every way to represent him this morning. This gentleman was at one time a marine engineer, one

of the most prominent engineers on the lakes. There was no steamboat in those days large enough to utilize all his ability, and he became one of the noted lawyers of the State of Michigan. He is now the Corporation Counsel of the City of Detroit. It gives me great pleasure to introduce to you Hon. Timothy E. Tarsney.

Hon. Timothy E. Tarsney: Mr. Chairman and gentlemen of the Convention, I am exceedingly sorry that our distinguished, able, genial and hospitable Mayor is not here to welcome you in person this morning, but, as suggested by your Chairman, he has sent me here in his stead to occupy, though I cannot fill, the place that he was expected to fill. But in his name and on behalf of the City of Detroit, I bid you welcome to our beautiful, our growing, our prosperous City of Detroit, this great city of home owners, commercial metropolis and center of business enterprise. Upon the bosom of the great river that flows by our doors floats the largest commerce that enters any harbor in the world. You will find your welcome here generous and hearty, and your stay a pleasant one. I deem it more than an honor to be requested to come here this morning and to welcome you, because you represent progress, science, industry, growth and advancement. Perhaps there is no business in the industrial and scientific world where the growth of industrial art and the advance of science is as marked as it is in your profession. We need only take a retrospective view of the last few years to find that the old fireplace, with its andirons and its back logs, has given way to the box stove, and it in turn to the beautiful base-burner manufactured in this city and elsewhere; that in turn to the furnace; again to the steam and the hot water plant, until you have advanced to that degree in your science and in other sciences where health and comfort are both combined. And yet I take it that your work is not yet done. Your meetings here and your meetings elsewhere are full of fruit. The world is a progressive world. Men are broader; they are more humane than in the days gone by. Even in my day and yours, Mr. President, it was a common thing for a scientist or a theorist, when he evolved an idea, to be selfish with it, to keep it to himself, but that day has changed; you have broadened, and you meet here to-day with the best thought and the most advanced ideas from all parts of the world to interchange thought,

to interchange ideas, and by the friction of conflicting thought evolve new thought and new ideas which will inevitably lead to further great advancement and development in your work.

My friends, on behalf of the Mayor of this city, on behalf of our three hundred and fifty thousand inhabitants of the city of Detroit, I bid you welcome, thrice welcome, to our midst, and express the hope that you will have a pleasant and a profitable visit with us. (Applause.)

The President: In looking over the members to reply and to thank his honor for his kindness to us this morning, I thought of a gentleman who makes it a business to criticise the speeches of others, and sometimes, if they don't suit him, he has a faculty of changing them to suit himself, and then they generally suit the one who spoke a little better than what he said. This gentleman is from New York, and is one of the most unselfish men of whom I know. He devotes more time to the interests of this Society than he does to his own interests. I have the pleasure of introducing my brother member of this Society, Mr. Frank K. Chew, of New York. (Applause.)

Mr. Frank K. Chew: It is a great pleasure to have the compliment paid to us of having one of the foremost officials of a progressive, ambitious and already great commercial center lay down the affairs of his government to come and pay a tribute to our Society. I shall have to be just a trifle conceited here if I am going to carry out the programme which Mr. Harvey has indicated, and say that this Society is worthy of the tribute that the gentleman has paid to us. Without any sordid aims or ambitions, the brightest thought of some of the brightest men identified with the heating and ventilating trades of the United States has enabled this Society to put out nine volumes of invaluable literature. They come here and discuss things that are almost invaluable to themselves, and express them freely and gratuitously for the benefit of all. Our invitations to the friends of the Society are open to any citizen of Detroit who is interested in the branch of industry which this profession represents, and they can come here and find what these experts know from absolute experience in their own work. So that when Mr. Tarsney has left his office and come here to welcome this body to this city—while it is not as large as some other bodies that have come here, representing no great commercial interest in

a sense, only professional ambition to do good to everybody—we certainly do heartily appreciate the tribute that has been paid to us by this important city through its Corporation Counsel. On behalf of the Society, I thank the city officials and those members of the business interests of this community who have made arrangements to make our stay here a pleasant one. We heartily thank you, gentlemen. (Applause.)

The President: In beginning I would like to make a statement, that there is an unwritten law in our Society which allows us the privilege of extending to any visitor who comes to our meetings the courtesies of the floor to discuss any subject which may come up at any time, and it will give me pleasure to follow that custom at this meeting. We hope you will be perfectly free to tell your experience and give us any additional information that will be of interest to this Society.

The Secretary: The first paper is "A Review of Some Heating Literature (continued)," by Hugh J. Barron, a member of our Society. It is virtually a continuation of the paper which he presented to the annual meeting last January in New York.

The paper was read by Mr. Barron and discussed by Messrs. Chew, Feldman, McElfatrick and Professor Hoffman.

The Secretary then presented Topic No. 1 for discussion. It was: "Are the commercial demands upon the time of our members the only hindrance to the presentation of tabulated or descriptive experience of their work?"

The topic was discussed briefly by Mr. Chew.

Topic No. 2, "Vacuum Systems of Heating," was then discussed by Professor Hoffman and Messrs. Munroe, Hoyt, Blackmore, Brennan and Secretary Mackay.

Topic No. 3, "How and to what extent, if at all, can the effect of humidity upon the sensible temperature of a room be modified by ordinary heating and ventilating apparatus," was then discussed by Messrs. Chew, Smith, Mason, Collamore, Munroe, Capron, Folsom, Blackmore and Secretary Mackay.

The President: If there is no further discussion on this subject, I would like to make one statement. The Chairman of the Entertainment Committee, Mr. William Inglis, of the American Blower Co., and Mr. Downs, of the American Radiator Co., wished me to announce that to-day the steamer "Sapho" will leave the foot of Woodward Avenue at 5 o'clock for Bois

Blanc Island. All those who are members or guests of the Society will please see that their names are registered before they leave, because the names must be in before 2 o'clock in order to provide places for them. This afternoon the ladies will leave here at 2.30 for an automobile ride, and will return to the hotel in time to accompany the gentlemen to the boat at 5 o'clock.

The convention then adjourned until 2 o'clock P.M.

SECOND SESSION.

The second session of the convention was called to order by President Harvey at 2.30 P.M.

Professor James D. Hoffman read a paper entitled, "The Education of Heating and Ventilating Engineers."

The President: We thank Professor Hoffman for this paper. It will prove of much value to the profession. Is there any discussion of this paper?

The Secretary: Professor Carpenter expects to be here this afternoon, and also Professor Kinealy. I suggest we do not finish the discussion this afternoon, but that it be laid over, as these gentlemen will be prepared to discuss the question if given an opportunity.

The President: The two gentlemen whom the Secretary has mentioned are the two who are most interested in that line of thought, and if there is no objection we will proceed to the discussion of the next topic.

The Secretary: The next topic for discussion is No. 4:

"Does the practice of consulting engineers, with respect to heating and ventilating matters, admit of uniformity in prices for services, and if so, in what direction and to what extent?"

The topic was discussed by Mr. G. W. Scott in a letter to the Secretary and by Messrs. Blackmore, Feldman and Secretary Mackay.

The President: Is there any further discussion on this topic? If not we will proceed to No. 5.

Topic No. 5 was read by the Secretary as follows:

No. 5. "Has the recent discussion of the Plenum System of heating in England added any new and useful information on this branch, or conclusively demonstrated any point?"

The topic was discussed by Messrs. Feldman, Smith, Blackmore, Brennan and Dean.

The Secretary then read Topic No. 6 as follows:

"Do the increased benefits of fan over gravity systems offset the operative necessities?"

The topic was discussed by Messrs. Chew, Brennan and Munroe.

The convention then adjourned until 10 o'clock A.M., July 16.

The closing session of the mid-year meeting was called to order at 10 o'clock on Saturday, July 16, 1904, by the President, and the meeting listened to the reading of a paper on "Advanced Methods of Warm Air Heating," by Mr. A. O. Jones, of Battle Creek, Mich.

The paper was discussed by Messrs. Thompson, Chew, Geo. D. Hoffman, Blackmore and Professors James D. Hoffman and R. C. Carpenter.

Topic No. 7 was then read by the Secretary and, at the suggestion of the Chairman, Topic No. 8 was also read, so that the two might be considered at the same time. They were as follows:

No. 7. "Is it possible to positively change the air in a building a given number of times per hour?"

No. 8. "Is there any system of heating and ventilating school rooms by means of pressure or exhaust fans, or both, which will not by thrown out of balance by opening windows?"

Topics 7 and 8 were discussed by Secretary Mackay.

Topic No. 9. "Is there a better method of testing the efficiency of the steam radiator than weighing the condensation from it when it is surrounded by air at a stated temperature?"

There was no discussion of this, and the Secretary presented the following additional topic:

"Is it a good practice to design an especial heating system by direct radiation to take care of the heating when outside temperature of air is above, say, 30 degrees Fahrenheit, and supply the additional amount of heat by a fan when the temperature is below that point?"

It was discussed by Secretary Mackay, Messrs. Blackmore, Brennan, Feldman, Geo. D. Hoffman, Jones and Collamore and Professor James D. Hoffman.

The President: The semi-annual meeting is just about to close. I want to thank the members for their kindness in com-

ing so far, some of course much further than others, and I hope that they have received some benefit from the discussions. I also want to thank the guests who have come here, and I want them to know that we fully appreciate their presence, and will be glad at all times at any of our meetings to see any of them, and if they should find that there is sufficient interest in this Society to warrant them in becoming members of it, it will give us also much pleasure to have them. We thank you all, gentlemen, for coming to this city of Detroit, and I hope to see you again. The meeting is now adjourned.

The Convention then adjourned *sine die*.

MEMBERS PRESENT AT DETROIT MEETING.

HOMER ADDAMS,	JAS. H. DAVIS,	ANDREW HARVEY,
J. J. BLACKMORE,	WM. C. DEAN,	J. D. HOFFMAN,
J. S. BRENNAN,	A. C. EDGAR,	W. M. MACKAY,
E. F. CAPRON,	A. M. FELDMAN,	E. K. MUNROE,
R. C. CARPENTER,	C. G. FOLSOM,	J. P. SCHAFFER,
H. M. CARRUTHERS,	JOHN O. GALLOUP,	H. A. SMITH,
F. K. CHEW,	H. B. GOMBERS,	W. R. STOCKWELL.

GUESTS PRESENT AT DETROIT MEETING.

J. P. BERRY,	CLARENCE HARVEY,	E. E. MEYERS,
C. R. BRADBURY,	GEO. HARVEY,	WM. F. MCDONALD,
GEO. M. BRILL,	JAS. HARVEY,	J. E. F. MCELFATRICK,
W. H. CHAPMAN,	RASMUS HERLOD,	J. T. MCELFATRICK,
E. I. CHASE,	GEO. D. HOFFMAN,	W. W. MONAGHAN,
R. COLLAMORE,	THOS. HOPWOOD,	E. A. MORRIS,
D. I. COOKE,	A. T. HOYT,	E. O. POLLARD,
G. E. DOWNE,	JAS. INGLIS,	ROBERT SPROUL,
C. C. DUEL,	J. M. JOERISSEN,	R. S. THOMPSON,
B. R. FALES,	A. O. JONES,	H. S. VAN VOT RENBURGH,
H. G. FIELD,	H. I. LORD,	
JOHN FRIX,	G. R. LEONARD,	F. F. VAN TAYL,
JOS. GRAHAM,	W. W. MACON,	J. M. WALKER,
BENJ. GUINER,	F. H. MASON,	H. F. WELSH,
A. A. HARE,	W. R. MAUNTETTO,	EDWARD WOLF.

CXXX.

A REVIEW OF SOME HEATING LITERATURE.

(Continued.)

BY HUGH J. BARRON.
(Member of the Society.)

As my paper read at the January (1904) meeting covered a reference to the work scattered through the proceedings of the Master Steam Fitters' Association, and incidentally referred to the papers read before the British Institution of Heating and Ventilating Engineers, I deem it advisable to make slight reference to the papers read at various times by engineers before the American Society of Mechanical Engineers, for the benefit of students who may desire to map out for themselves a complete course in heating literature. This will also cover the recognition of the fact that our Society evolved from the American Society of Mechanical Engineers as well as from the Master Fitters' Association. The American Society of Mechanical Engineers was founded in 1880 and, in the twenty-four years elapsed, there have been some valuable discussions in reference to details of the heating art and of those branches of engineering closely related to it.

In the first volume of the Transactions of the last named society for the year 1880, there is no special matter relating to heating, but there is a valuable paper on "The Value of the Study of the Mechanical Theory of Heat" by the well-known engineer Alfred R. Wolff.

In Vol. III. (1882), there is a paper by W. T. Trowbridge, Professor of Engineering at Columbia College, which is entitled "The Determination of Heating Surface Required in Ventilating Flues."

In 1883, W. J. Baldwin contributed a paper on "Standard Cast Iron Fittings," which was ably discussed by several engineers who were present. Mr. Baldwin, I believe, advocated greater refinement and William Barnet Le Van seemed to think

that the old Morris and Tasker fittings were good enough for all purposes. There are many of this way of thinking still among engineers and the "good enough" family is extremely influential as any one finds out who proposes anything new. In the same year Prof. R. H. Thurston contributed an interesting paper on "Water Hammer in Steam Pipes."

The next paper was contributed by John W. Anderson in 1885, on "Adaptation of Steam Boilers to Warming Dwelling Houses."

In Vol. VII. (1885), W. J. Baldwin contributed a paper on "Notes on the Comparative Value of Metal Surfaces for Warming Air." In the same volume is found a paper by George M. Bond on "Standard Pipe and Pipe Threads," and another interesting paper by W. T. Trowbridge on "The Relative Economy of Ventilation by Chimneys and Ventilation by Fans."

A very important report was made by a Committee on "Standard Pipe and Pipe Threads" in 1886 and is found in Vol. VIII (1886-87) of the Proceedings. In the same year, Charles E. Emery contributed a paper on "The Comparative Value of Steam and Hot Water for Transmitting Heat and Power."

Vol. IX. (1887-88), contains quite a number of papers, among these may be noticed "Experiments and Experiences with Blowers," by Henry I. Snell, and another paper by the same author on "An Economical Method of Heating and Ventilating an Office and Warehouse Building." J. T. Hawkins contributed a paper on "Automatic Regulator for Heating Apparatus." Henry R. Towne contributed a paper on "A Safety Car-Heating System," and W. J. Baldwin "Notes on Warming Railroad Cars with Steam."

In Vol. XI. (1889-90) there is found a paper by C. H. Peabody and J. H. Kunhardt on "Flow of Steam Through Orifices;" Prof. R. C. Carpenter in the same year contributed a paper on "Comparative Test of a Hot Water and a Steam Heating Plant."

All that seems to be of interest in the following year are two papers on heat transmission, contained in Vol. XII., one by Prof. R. C. Carpenter on "Heat Transmission Through Cast-Iron Plates Pickled in Nitric Acid," and another by Daniel

Royse on "Heat Transmission Through Plates Pickled in Nitric Acid."

The next paper of any importance is found in Vol. XV. (1893-94), contributed by W. A. Pike on "Steam Piping and Efficiency of Steam Plants."

Vol. XX. (1898-99), contains a number of interesting papers which have reference generally to the mechanical plants of modern buildings. Among these may be mentioned "The Mechanical Plant of a Modern Commercial Building," by W. H. Bryan; the "Equipment of Tall Office Buildings in New York City," by Reginald Pelham Bolton; "The Central Heating Plant of the University of Wisconsin, at Madison, Wis.," by Storm Bull. In addition to these numerous papers there is one by Prof. R. C. Carpenter on "Experiments on the Flow of Steam Through Pipes."

Central station heating comes in for discussion in a paper by H. T. Yaryan on "Hot Water Heating of a Central Station," which is found in Vol. XXI. (1900) of the Proceedings. This paper was discussed by George I. Rockwood.

In. Vol. XXIII. (1902), there is a valuable report of the Committee on "Standard Pipe Unions" and in Vol. XXIV. (1903), the topical discussion on "Smoke Consumption," by E. P. Bates and Gus. C. Henning is very interesting. The two methods of prevention of smoke are very ably discussed.

At the recent summer meeting of the Mechanical Engineers, there were two papers read which touch upon the province of the heating engineer. These papers have reference to New York office buildings, and were contributed by James Hollis Wells and Reginald Pelham Bolton.

I have not attempted to review in detail the various papers nor do I think it necessary, as they can be found at any public library, and a search for the heating papers through the transactions will disclose other interesting matters.

It should always be borne in mind that a number of motives are responsible for the preparation of any paper The first and ostensible motive is the scientific spirit—the desire for the propagation of engineering facts. The second is the indirect commercial motive to obtain publicity for a certain new or pseudo new product. The third incentive is that of personal advertisement.

All of these motives are modified by the commercial instinct of prudence that no information which might be of value to a competitor should be divulged. This may be noticed in almost all papers, and in the discussion of them before nearly all engineering societies. The fact is, so-called really clever men rarely discuss papers. They take the Philistine attitude that the information which they have acquired by their personal enterprise is their own property. They forget that it is the property of the race, and that it is their duty to share it with their contemporaries and transmit it to their successors.

I think it is recognized to-day that our society is the proper one for the discussion of problems relating to heating and ventilating engineering. Before our organization, such work was in the province of both the Mechanical and Civil Engineers' Societies. Robert Briggs's great paper was presented to the Civil Engineers of Great Britain.

I know there is a feeling among some engineers that our Society was not necessary and that the general societies covered the ground fairly well, but I am convinced that this is an entirely mistaken view and that our existence is fully justified by our work.

DISCUSSION.

Mr. Frank K. Chew: The thought that comes to my mind in connection with this paper is a lesson for the members here. This is a recounting of past history, and is one of the most valuable papers that can be presented to the Society, the recounting of what has been done; whether a man has heated a factory with exhaust steam, or whether he has used a hot water system in a building or a fan system in a church; if he takes the fire surface or the grate surface and makes a record of it he is adding new data which are invaluable for the guidance of men who have not worked in that field, but who may be called upon to work in it, and who, without some information to guide them, are liable to suffer financial loss. If this paper is valuable to the Society in knowing where good, safe information can be had, then it should be an incentive to each one of our practical members who are engaged in installing work of any kind to pick out from their own work something for description at a future meeting.

Mr. A. M. Feldman, of New York: I know of one paper published by the American Society of Mechanical Engineers on the Central Power Plant of Columbia University, a very exhaustive paper. I want to add that paper to Mr. Barron's list.

Mr. J. T. McElfatrick, of Detroit: The paper that was read before the American Society of Mechanical Engineers by Mr. W. H. Pierce, of Chicago, at their last meeting was a valuable paper to every member of this organization, and can be secured by writing to Mr. Pierce, 263 Dearborn Street, Chicago.

Professor James D. Hoffman: It seems to me that in our future considerations of the subjects to be presented at the meetings of the Heating and Ventilating Engineers one important subject that should be brought out very prominently, and one that has not been touched upon, is the discussion of central heating plants, both steam and hot water. I am sure in my part of the country that this method of heating is taking a very prominent place. It is a subject which is not very generally understood, but one upon which a great deal of experimental work is being carried on, and I should like to see it discussed at the meetings of this Society on future occasions.

Mr. Frank K. Chew: I hope Professor Hoffman will express the different things that he would like to have discussed in detail, not for this particular meeting only, but for some future time. I think that a series of questions in the form of a paper, if it does not do anything else but let the members at home dig the thing up for themselves along systematic lines, would be of benefit.

Professor James D. Hoffman: I have in mind in bringing up the subject some things that have confronted me in my work with the students in Purdue University and I think, as the gentleman suggests, that we can bring forth a good many questions. I don't say that I could answer them myself, but possibly some one might. I should be very glad to dig up these questions at some future time and bring them in. I am sure they would be of interest in trying to solve them.

Mr. George M. Brill, of Chicago: At the recent meeting of the National Electric Light Association held in Boston a paper was presented on "Steam Heating and Hot Water Heating Plants." Perhaps more of the commercial side of it than the technical side was presented, but withal it was a very interest-

ing paper. I think copies of that could be available by addressing the secretary of the National Electric Light Association. It is the result of a series of questions sent out to a hundred different heating plants, most of them operated in connection with lighting and power plants, and brings out a great deal of valuable information.

CXXXI.

THE EDUCATION OF HEATING AND VENTILATING ENGINEERS.

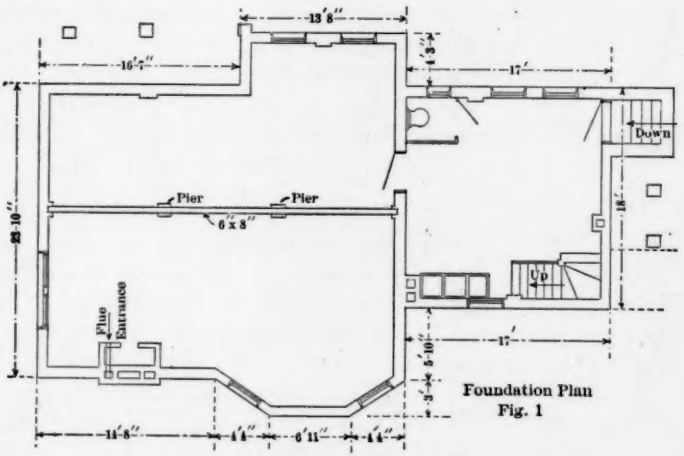
BY JAS. D. HOFFMAN.
(Member of the Society.)

Historical.—Before entering upon a discussion of the subject proper a few words may not be amiss concerning the past and present conditions which have to a certain degree influenced the branch of engineering known as Heating and Ventilating Engineering. From a careful comparison of the standing of this branch of engineering with that of other branches, one is struck with the fact that the former has been completely outclassed in the process of development. It would be difficult to assign any one cause for this. It is probably due to the aggregate of a number of causes. The fact that there has been small demand for men trained specially in this branch shows that the general public has been only moderately interested, since in all lines of work it is evident that the demand largely controls the supply. A demand is made for certain materials by the public and the supply is forthcoming. In railroad competition, rapid transit, which is so necessary to the public, is met with improved rolling stock and road bed. In manufacturing lines quick and cheap production requires and obtains improved automatic machinery. In agricultural pursuits demands are made for labor-saving machinery constructed with the highest type of mechanical skill. In that part of engineering, however, which relates to the furnishing of buildings with the best of heating and ventilating apparatus the demand has been very slow in coming, and consequently the development of this work has been very slow.

In years past and not very far past either, a building was supposed to be satisfactorily heated if it had the regulation number of stoves and fire-places, and ventilation was considered

sufficient through the opening of doors and windows. With improvements in all other lines of engineering moving at a terrific rate it is strange that this one branch has been sadly neglected; the tendency in the last few years, however, has been toward improvement, and in the near future we will see it taking on an unusual growth.

Several reasons can be assigned for the apparent satisfaction that the people have with the old methods of heating. Among them are the following: First, the heavy first cost of improved



Foundation Plan
Fig. 1

systems requires an outlay of money at the start that most people are not willing to incur; second, a willingness to heat only a portion of the house while the remainder is closed off during extremely cold weather renders a complete heating system unnecessary; third, the style of architecture used in most of the towns and villages is not sufficiently elaborate to justify the expense of a heating plant; fourth, in the parts of the country that are blessed with natural gas the gas heater is so light, convenient and efficient that no other system of heat was thought of than that of the direct heat from a gas heater.

The first and second reasons, of course, come from a very laudable ambition toward economy and will always prove the ruling factors; the third reason is being removed as new and more modern buildings take the place of the old, and the fourth

applies to the gas belt only, where the failing supply of the gas tells plainly that other methods of heating must soon be adopted. In certain localities natural gas is already a thing of the past; where this is so the people who have been accustomed to the luxury of gas heating for a number of years are not willing to go back to the wood stove, but look for some improved method. This tendency toward providing more uniform heat and more economical systems than that of the stove is not confined to the gas belt alone, but is increasing rapidly in all sections. As a natural result in the evolution from the conditions named above there is springing up a demand for men who are specially fitted for the designing and installation of heating and ventilating apparatus.

METHODS OF TRAINING FOR HEATING AND VENTILATING ENGINEERS.

The question then presents itself, how and where can this training best be given?

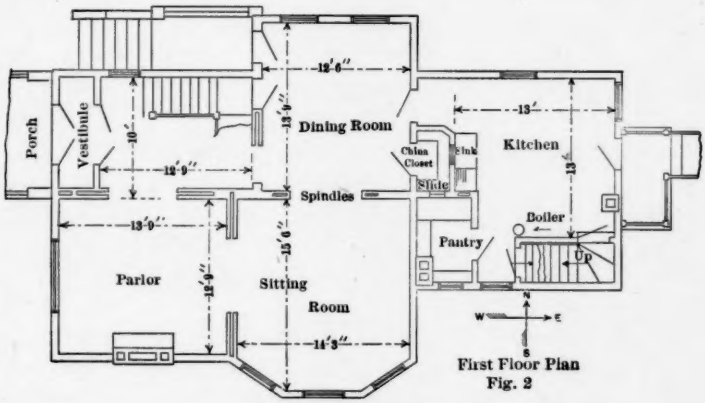
There appear to be three avenues open to such training: First, self-development without the direct oversight of an experienced engineer. In this case we assume the person to have a good practical knowledge of the art of plumbing with a reasonable degree of good judgment. As a result, since he must profit largely by his own experience, it takes the average man some time to distinguish cause from effect and his development is slow. Under such conditions designs must always be modelled after other existing designs, or else there is great danger of a defective plant. Second, a practical training received in an engineer's office under the guidance of skilled designers. This might be called the apprenticeship system in heating and ventilating engineering. Here he becomes experienced in the various processes, from the making of blueprints and tracings to the laying out, designing and installing of the heating system. Third, a technical training, such as is given by some of the technical schools of the country.

TECHNICAL TRAINING.

Each of the above styled avenues of instruction, it must be assumed, has its advocates. It is not thought wise or expedient

here to make comparisons; it is the desire of the author, however, to elaborate upon number three to the extent that a full course of instruction, such as might be adapted to any of the technical schools,* will be outlined. It is not the belief of the writer that what follows can, as it stands, fit all conditions, but rather that it will serve to bring out further ideas along this line and stimulate friendly criticism to the end that an engineering student in any technical institution who wishes to specialize along this line of engineering may have the best possible equipment when he leaves.

The chief objection to the technical graduate is that he is



First Floor Plan
Fig. 2

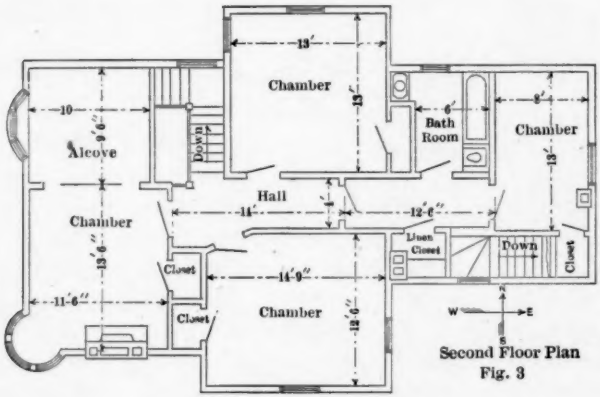
not practical. It is the object of this paper to outline a *practical* course in heating and ventilating which may, in a certain degree at least, remove the above criticism.

Preparation for the Course.—The subject of heating and ventilation should, if possible, be taken up during the last year of college work, when the student can have the benefit of a large part of the training in Heat, Thermodynamics, Machine Design and Steam Engines and Boilers, all of which subjects are fundamental in this work. The subjects of Heat and Thermodynamics fit him with facts and figures for analytical investigation concerning heat transference, while a knowledge of engines, boilers and general machinery gives him information of a more

* The outline as presented covers the Course in "Heating and Ventilation" as given to the senior class at Purdue University, Lafayette, Ind.

practical turn, the application of which is of great value to him in heating design.

It may be assumed with a preparation as suggested, that a man is fairly well grounded in the fundamentals concerning heat transmission and that a course well qualified to fit him for active participation in heating affairs after leaving school should emphasize such points as will give him a knowledge of the materials of construction, such as pipes, fittings, and general plumbing. A course then fitted to his needs should not only require a calculation of heat losses, square feet of radiation, sizes of pipes, kinds of fittings, size of boiler, including grate surface,



Second Floor Plan
Fig. 3

etc., but it should require a complete layout of the entire system. This in a hot air system would include the location of the furnace, cold air duct and all leader pipes, risers and registers; while in a hot water or steam system it would include the location of the boiler and all pipe lines and radiators.

Scope of the Course.—The course should be administered part in the class room as lectures and recitations, and part (a set of designs) should be left to the student to work up largely upon his own responsibility, and submit the same for approval.

The work in the class room should be at least two hours per week and should be chiefly lectures with an occasional recitation. In the lectures very full references should be made to the various authorities on Heating and Ventilating with suggestions that these authorities be looked up. They should also

include very full details concerning the laying out of such work, with suggestions concerning the proper selection of materials. The recitations should be made as practical as possible to serve in bringing out the points that would probably be confusing in developing the designs. All class room work should be timed to suit the design under consideration, otherwise the design work and the class room work will be independent rather than mutually helpful.

The work of design might very properly cover the following systems of heating:

(1) Furnace heating, as applied to residences. Time allowed, three weeks.

(2) Hot water heating, as applied to residences. Time allowed, three weeks.

(3) Steam heating, as applied to residences. Time allowed, three weeks.

(4) Blower system of warm air heating, as applied to schools and office buildings. Time allowed, three weeks.

(5) Exhaust heating, as applied to high office buildings. Time allowed, two weeks.

(6) District heating from a Central Station. Time allowed, four weeks.

The above outlines will be found to cover the work very thoroughly and should be administered in such a way as to remove as much of the purely routine work as possible, otherwise the course which is planned for one-half year's work would be too long for the time allowed to the average student by the school curriculum. As an illustration: the student prepared for this work is fairly well qualified to make mechanical drawings and any relief which can be given him from his drawing work will permit the equivalent time being put to other and more important parts of the design. This relief can take the form of prepared building plans stamped off on standard sized paper, thus permitting him to insert his heating drawings on these same pages without the routine labor of reproducing an entirely new set of drawings.

In every design, say of a residence, the student should be presented with the three stamped plans, basement, first floor, and second floor (see samples, Figs. 1, 2, and 3), accompanied by a full and complete statement of the owner's wishes con-

cerning the kind of plant desired. The student then considers himself in the position of a heating engineer who is retained to draw up plans and specifications for the said owner. In the development of the design certain points should be discussed in the class room, with all taking part. Sample specification sheets should be struck off covering the installation of typical systems and these will assist in guiding the designer in his work.

Beginning with design No. 1 the designer's instructions should be given to him on separate sheets of standard size, the same to be submitted as a part of his finished design. These sheets may contain material about as follows:

Instruction Sheet F.

Hand in Sept. — '03.

FURNACE HEATING PLANT FOR A TEN ROOM RESIDENCE.

This instruction sheet with the accompanying plans and sample specification will form the basis for the design of a furnace heating plant for the said building. Your attention is called to the following points for which you will fully specify.

Register: Net area, nominal size, elevation of wall registers and location of floor registers.

Riser ducts: Exposed or built in, covered or not covered.

Leader pipes: Direction, pitch and net area.

Cold Air Pipe: Location, construction and net area.

Furnace: Location with reference to leader pipes, flue and firing; elevation; calculated grate area; make of furnace and catalogued grate area.

Foundation: Material and construction.

Accessories: All fittings and tools needed for complete furnace equipment.

NOTE.—On account of the reduced size of the building plans it is found advisable to specify here as follows:

Basement: 6 feet 6 inches ceiling.

Furnace room not ceiled or heated.

Laundry, ceiled and heated partially; three windows 3 feet x 2½ feet and one window 2½ x 2½ feet.

First floor: 10 foot ceiling.

Do not heat vestibule, china closet, or pantry. All windows

3 feet x 6 feet, except front hall, 2½ feet x 4 feet; parlor, 6 feet x 6 feet; sitting room, 4 feet x 6 feet; kitchen, 2½ feet x 4 feet.

Second floor: Ceiling 9 feet.

Do not heat closets; all windows 3 feet x 5 feet, except alcove, 25 square feet; chamber, 35 square feet, and bath, 2½ feet x 4 feet.

Scale of plans, ½ inch = 3 feet.

Instruction Sheet H.

Hand in Oct. — '03.

HOT WATER HEATING PLANT FOR A TEN ROOM RESIDENCE.

This instruction sheet, with the accompanying plans and sample specification, will form the basis for the design of a hot water heating system for the said building. Your attention is called to the following points:

System: The system preferred is the low pressure, two-pipe direct radiation.

Radiators: Specify location, square feet of surface, style and height.

Piping: Lay out entire system of piping and specify size and pitch of mains and branches, size of risers, valves, fittings and connections.

Expansion tank: Size, type and location.

Heater: Calculate grate area; select type and size of heater and specify catalogue grate area. It will be seen that heaters are rated *including mains and risers.* Notice if the main and return tappings as catalogued agree with the computed sizes of the mains and returns.

Concerning the plans: All sizes of windows, height of ceiling, etc., may be taken the same as in the furnace design.

Instruction Sheet S.

Hand in Oct. — '03.

LOW PRESSURE STEAM HEATING PLANT FOR A TEN ROOM RESIDENCE.

This instruction sheet with the accompanying plans and sample specification will form the basis for the design of a low

pressure steam heating plant for the said building. Your attention is called to the following points:

System: The system will be the (one pipe or two pipe) plan with (basement or attic) mains.

Radiators: Specify location, square feet of surface, style and height.

Piping: Lay out entire system of piping and specify size and pitch of mains and branches, size of risers, valves, fittings and connections.

Boiler: Calculate grate area; select type and size of boiler and specify catalogued grate area. It will be seen that boilers as well as heaters are rated *including mains and risers.* Notice if the tappings at the headers as catalogued agree with the calculated sizes of the mains.

Concerning the plans: All sizes of windows height of ceilings, etc. may be taken the same as in the furnace design.

Instruction Sheet B.

Hand in Nov. — '03.

A PLENUM SYSTEM OF WARM AIR HEATING FOR A TYPICAL COLLEGE BUILDING.

This instruction sheet in connection with the accompanying plans and sample specification will form the basis for the design of a Plenum system of warm air heating for the said building. A full and complete set of working plans and specifications are desired. In doing this valuable information can be obtained by inspecting the plants in buildings heated in this way. Your attention is called to the following points:

1. The entire building is to be heated to 70 degrees Fahr. in zero weather, having the velocity of the air not to exceed five feet per second at the register and the entering air at a temperature of 140 degrees Fahr.

2. Locate and give sizes of all ducts and registers both heat and vent.

3. Show on basement plans the runs of heat ducts with branches from the blower to the riser ducts.

4. Locate and specify as fully as possible for the installation of the blower system with its accompanying brick work and intake.

5. Give fully the amount of heating surface in linear feet of pipe, and specify the kind of heater to be used.

6. Such other details of construction as go to make the plant a complete working system.

Note: Since the basement is to be used by classes all main ducts must go below the basement floor. This will give a downward pitch to the main duct as it leaves the blower.

Instruction Sheet W.

Hand in Dec. — '03.

A DESIGN OF A ..... VACUUM HEATING SYSTEM FOR A FOURTEEN STORY OFFICE BUILDING.

This instruction sheet together with the accompanying plans will form the basis upon which you will design a ..... Vacuum Heating System for the said building.

The following assumptions, all of which are reasonable, will be understood to form a part of the work.

1. The building above the basement may be so planned as to give each floor practically the same layout, hence, the one floor plan is added to give a conception as to how the building is designed and where the riser pipes are located. This plan may be accepted as a part of the design without modification.

2. The building will have .... radiators, ... to each floor including basement, so placed as to attach conveniently to the riser pipes as shown. The riser pipes will supply heating surface as follows: 1, 5, 8, 9, ... square feet each; 2, 3, 4, 6, 7, 10 11, 12, ... square feet each.

3. About .... boiler H. P. will be needed, say three .... H. P. .... boilers for power and heat in such a plant and this should be planned for. Connect with a header pipe say .... inches diameter.

4. Three direct connected engines and dynamos will be needed having ...., ... and .... H. P. respectively. These engines will connect to an exhaust header which will form the reservoir from which we lead the main steam heating pipe or pipes.

5. .... Vacuum pumps or exhausters and a .... heater will also be installed.

It is not to be understood that the full boiler H. P. or the

full engine H. P. will be used all the time. This should be compiled out of smaller units so connected that any one or all may be used according to the demands.

6. Other necessary features of such a vacuum plant not mentioned here should be noted on the plans.

It is suggested that one or more sheets of details will be necessary since a plan only of such a system does not fully explain it.

The chief features of this design will be the arrangement of the apparatus in the basement showing the flexibility of the plant for heavy and light service and the convenience with which it may be handled for heating purposes.

Instruction Sheet C. 1.

Hand in Jan. — '04.

A CENTRALIZED SYSTEM OF HOT WATER HEATING FOR A RESIDENCE OR BUSINESS DISTRICT.

This instruction sheet together with the plan of the city showing the portion of the city to be heated will form the basis upon which you will design a centralized *two pipe hot water* * heating system for the said locality.

The plant is to be installed in connection with the Municipal Lighting and Pumping station of ..... The equipment of the present plant which will need to be considered in connection with your design may be assumed as follows:

Engines .... H. P. total,

Boilers, ... H. P. total,

Pumps on City Service, two .... gal. capacity each.

You are limited to a heating capacity of not more than .... square feet of radiation. The plan of the city is shown in Sheet C 2 with the business and principal residence district marked. From these districts you will assume the area needed to absorb the full amount of your capacity and draw up the plans and specification covering the street mains, typical house connections and power plant, giving especial attention to the latter.

No requirement will be made relative to the machinery now

* A single pipe hot water or steam system may be taken as well as the one given. The system chosen is probably as satisfactory in its solution as any.

installed. This may be counted as a part of the final estimate and may be arranged as the designer wishes.

In this design you are requested to notice the following points:

1. Layout of street mains with sizes of pipes.
2. Details of construction of conduit.
3. Expansion and anchor arrangements in conduits.
4. Power house arrangement, engine, boilers, pumps, heaters, etc.

You are required to take the above material and from the lectures previously given work up and submit the complete design and calculations.

Order of Arrangement in Design: When a design is submitted for approval it should be compiled as follows:

(1) Correction Sheet, to be used only for instructor's recommendation.

(2) Statement of the design, with such data sheets as have been given out by the instructor.

(3) Sample specification sheets.

(4) Plans and elevations.

(5) Calculation sheets.

Inspection of Designs: Every design should be carefully inspected and returned to the designer with the instructor's recommendation. These recommendations should be very general and should cover all points of design. If the design is very defective it should be reconstructed and returned a second time for approval.

Conclusions: In this work as in every other line there are some difficulties to be met with in its execution. The tendency of the average student is towards strict observance of formulae, a state of affairs not in accordance with good heating and ventilating design, consequently the ability of the instructor is put to the test of harmonizing the purely theoretical with the practical in a way that it will appeal to the student. The cultivation of a good judgment and the ability to form estimates with necessary allowances are absolutely essential in any design of this kind. In some of the exact sciences the student may be told that his results are wrong or right as the case may be, but in the work under consideration a number of solutions may be

offered for the same design each of which would be called good but not one of which would be called the best solution. The results then that must be expected from a class of such students will be decidedly varying in principle and imperfect in detail. During the progress of the work, however, these imperfections should gradually give way so that at the close of such a course each student will be able to give a fairly satisfactory account of himself.

CXXXII.

ADVANCED METHODS OF WARM AIR HEATING.

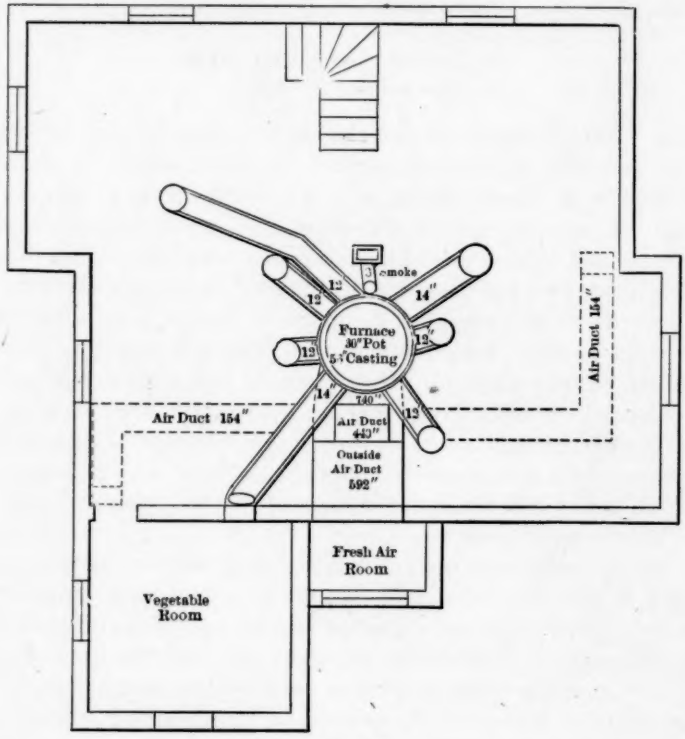
BY A. O. JONES, BATTLE CREEK, MICH.
(Non-Member of the Society.)

In consideration of the fact that a great many furnace dealers oppose a plan of warm air heating where two rooms are to be heated from one supply pipe, and knowing from experience that the same is practical, the writer is prompted to describe a system and attach herewith a plan of a residence which has been heated for the past three winters with a warm air furnace, where seven basement or supply pipes are used for heating thirteen rooms. These supply pipes have a larger area than would be necessary were they intended for heating but one room, and instead of conveying the necessary amount of warm air for heating each room through a separate pipe, the amount necessary for two rooms is conveyed through one large pipe, which has an area equal to the areas of the two pipes necessary to do the work separately.

While a prejudice has existed, and may exist at the present time, in the minds of a great many furnace dealers or warm air heating experts against a plan of heating two rooms from one supply pipe, it is no doubt owing to the fact that they have never given this system a trial, or because they have attempted to heat two rooms on the same floor by branching from the main supply pipe and attempting to carry the air in another direction, which would necessitate an angle, or possibly an elbow, to change the course of the air from the course it was traveling in the main supply pipe. In this case it is next to impossible to successfully heat two rooms with one pipe. The system herein described, however, is on an entirely different plan. Wherever it has been tried it has proved a success, and is admitted to be along advanced lines. During the past three years several thousand warm air furnace dealers have tried this system and have found it thoroughly practical.

XUM

By referring to the plans presented herewith, it will be seen that in the residence referred to, which is owned by T. Evans, of Battle Creek, Mich., there are six rooms and a hall on the first floor and six rooms on the second floor which have a total area of 23,548 cubic feet. It will also be noticed that there are

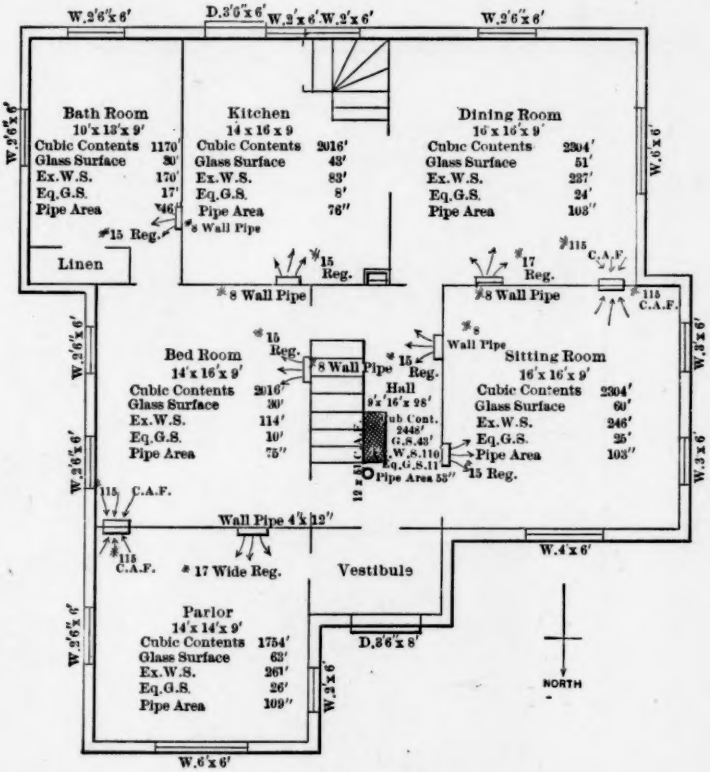


BASEMENT PLAN.

504 square feet of glass surface and 2,267 square feet of exposed wall surface, equivalent to 236 square feet of glass surface; in all, the equivalent of 740 square feet of glass surface.

In estimating the amount of warm air necessary for heating a given room, a plan, which has been followed successfully during twenty odd years of experience in the furnace business, is to reduce the exposed wall surface to glass surface, and divide the exposed wall surface by the thickness of the wall—in no

case less than 10—and this added to the actual glass surface, which, when multiplied by 75 and added to the cubic contents and multiplied by .013, gives the area in square inches necessary for heating a given room to 70 degrees F. when the outside temperature is at zero. One per cent. should be added

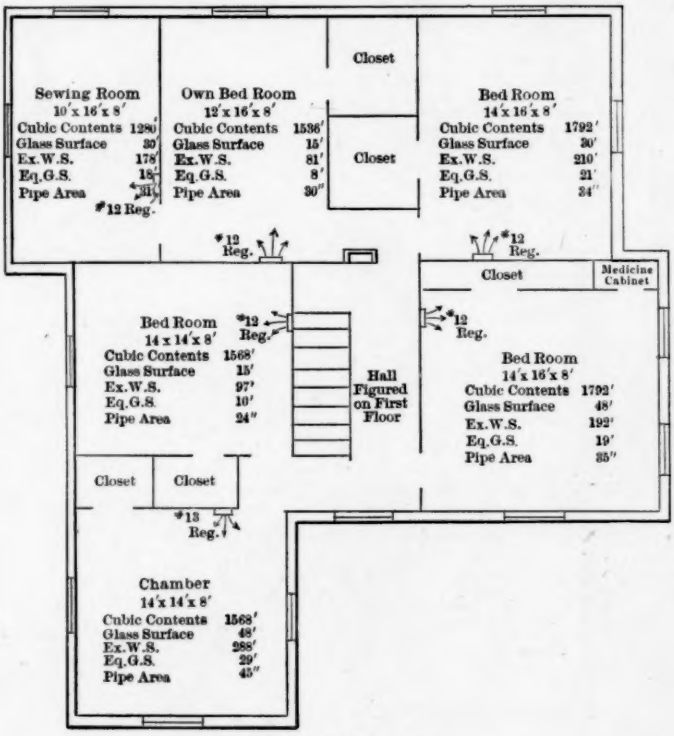


FIRST FLOOR PLAN.

for each degree below zero. This rule applies to warm air pipes for heating rooms on the first floor, where the velocity of the air in the basement pipes is 100 feet per minute, when the pipe has an elevation of 1 inch in 12; but inasmuch as the velocity increases when the elevation of the pipe is increased, and as the velocity of the air in the wall pipes leading to the second floor is 300 feet per minute, they can be much smaller; and, in

this case, the wall pipe which conveys the warm air to the second floor rooms has an area of 40 per cent. of the necessary area for heating rooms of the same size and exposure on the first floor.

By referring to the plan of this residence it will be seen that the registers are placed in the wall; and, in order to secure suffi-

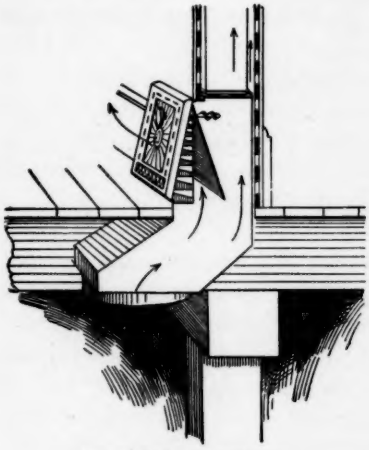


SECOND FLOOR PLAN.

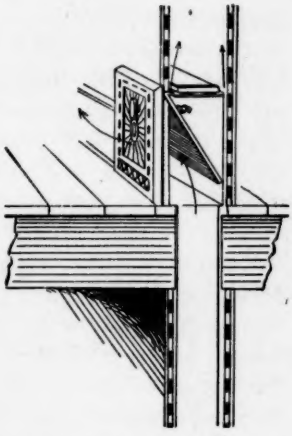
cient opening through the bottom of the register boxes, where they connect with the basement pipe, specially constructed side wall registers have been used, which are so constructed that they have an opening sufficiently large to take care of all of the air that the basement pipe can supply.

In the rooms on the first floor, where more than 78 square inches are necessary, and where the room above is also heated

from the same supply pipe, a No. 17 register has been placed, the bottom opening of which has an area of 113 square inches. This is connected to the furnace with a 14-inch pipe, which has 154 square inches area. The question, no doubt, will arise:



FIRST FLOOR REGISTER.



SECOND FLOOR REGISTER.

SPECIAL REGISTER.

How can 154 square inches pass through the bottom of this register, which has but 113 square inches opening? By way of explanation, I will say that in the basement pipe of 154 square inches, where the velocity is 100 feet per minute, 117 cubic feet of air will be discharged per minute; but the velocity of the air

increases when the elevation is increased, and as the elevation in this case is increased at the first turn of the elbow, it is estimated that this air is traveling at the velocity of 150 feet per minute when it is passing through the bottom of these register boxes. It will be seen that 79 cubic feet of air will pass through this opening at a velocity of 100 feet per minute, and 118 cubic feet at a velocity of 150 feet per minute, or more than a 14-inch pipe will supply. In rooms on the first floor, where less than 78 square inches are necessary, a No. 15 register is used; and as all of the rooms in this residence have been heated from 70 to 75 degrees F. during the coldest weather since this plant has been installed, some three years ago, it will be seen that the above estimates are correct.

It might be well to explain that while all but two of the rooms on the first floor require 78 square inches of the pipe area, and that 12-inch pipes with 113 square inches area are used to convey the air from the furnace to the bottom of these registers, the wall pipe, which continues from the top of the registers to the rooms on the second floor, has an area of 35 square inches, and, inasmuch as each register is supplied with an adjustable diaphragm, which can be used as a deflector, the warm air is divided while it is traveling upward, which is the only place that it can successfully be divided, and 55 cubic feet of air per minute is discharged into the rooms on the first floor and about an equal amount is discharged into the rooms on the second floor.

It is owing to the fact that the air for these two different rooms is divided, while it is traveling upward, or through a perpendicular conductor, that it is possible to successfully divide the air for the different rooms to be heated, while, if this division were undertaken while the air was traveling through a horizontal pipe, it will readily be seen that it cannot successfully be divided on account of the warmer air hugging the top of the supply pipe. If this division were undertaken while the pipe was running horizontally, the branch nearest the top of the supply pipe would naturally rob the supply pipe, and the other branch would not get its share of the warm air; in which case but one room would be heated successfully at one time, as has been proved in many cases. This no doubt has caused the prejudice referred to above.

In order that the description of this system may be more

thoroughly understood, a plan of the basement is given, showing the location of the furnace, air ducts, warm air pipes, etc., also the first and second floors, which shows the location of the warm air registers, pipes, and return air registers. After finding the amount of air necessary for each room and adding all together, we find how much air is necessary. The next thing is to have a furnace large enough to allow this amount of air to pass through it between the castings, or the furnace proper and the castings, and to have an air duct with sufficient unobstructed area to supply this amount of air. If this air is taken from the outside of the building, it will be well to remember that when heating it from a temperature of zero to 175 degrees above zero it will expand about 20 per cent., but if a greater allowance is made, the air supply in all probability will be inadequate; and more trouble has arisen in warm air heating from a lack of air than from a lack of heat, for it matters little how hot a furnace is, unless there is sufficient air delivered to it to utilize the heat as is passes over the furnace on its way to the rooms to be heated. Then, with a proper air supply, a furnace large enough to allow this air to pass through the warm air pipes, and the furnace so constructed as to heat this air while it is passing over the heating surface of the furnace, there can be no failure in warm air heating, if the rooms to be heated are properly ventilated, so that a circulation of air is secured, unless the warm air is cooled while passing through the basement pipes, and this can be prevented in a great measure by using a few large basement or supply pipes instead of using many small pipes or one for each room to be heated.

Any furnace manufacturer will guarantee his furnace to heat more space where one large register is used with one large supply pipe. Then is it not reasonable to suppose that a furnace will heat more space with the same amount of fuel with one-half the number of supply pipes, or the same space with less fuel?

As proof of this statement, you are referred to this residence, where but ten tons of anthracite coal was used to heat 23,548 cubic feet of space divided into thirteen rooms, where 2,267 square feet of wall is exposed to a climate where the thermometer registers as low as 22 degrees below zero, besides there

being 504 square feet of actual glass surface, the cooling effect of which has to be overcome.

Besides successfully heating this residence with a minimum amount of fuel, all of the rooms have been ventilated and the air throughout the house is kept free from impurities, which cannot be said of some residences heated with other systems.

Another feature of this system or plan of heating is that no coal dust or odor from the basement is delivered into the rooms, as no air from the basement can enter the warm air pipe; and air for protection, instead of being taken from the cellar or coal bin, is drawn out of the rooms being heated, through the opening at the bottom of the registers, which is made for the purpose of ventilating the rooms being heated and protecting the wall pipes from overheating.

SUMMARY.

Space heated	23,548 cubic feet.
Exposed wall	2,267 square feet.
Actual glass surface	504 square feet.
Actual glass and equivalent glass surface	740 square feet.
Number of rooms heated	13.
Number of basement pipes used	7.
Area of warm air pipes	740 square inches.
Area of outside air supply	592 square inches.
Area of inside air supply	740 square inches.
Area of air space in furnace	768 square inches.
Diameter of grate in furnace	30 inches.
Area of grate	670 square inches, or 4.65 square feet.
Heating surface of furnace	124 square feet.
Coal consumed during season	10 tons.
Proportion of grate to heating surface	1 to 27 square feet.
Proportion of heating surface to space heated	1 square foot to 193 cubic feet.
Proportion of heating surface to equivalent glass surface	1 to 60 square feet.
Proportion of grate diameter to exposed wall surface	1 to 76 square feet.
Proportion of pipe area to space heated	1 square inch to 31.08 cubic feet.
Proportion of pipe area to equivalent glass surface	1 square inch to 1 square foot.
Proportion of coal consumed to space heated	1 ton to 2,354 cubic feet.
Proportion of coal consumed to equivalent glass surface	1 ton to 74 square feet.

DISCUSSION.

The President: You have heard the paper read. Is there any gentleman in the furnace business or steam heating line who would like to speak on this paper?

Mr. R. S. Thompson, of Springfield, O.: I am very glad the hot air question is to be aired this morning. Steam and hot air and the fan system have their places. The only process for many years to come by which most people can change the win-

ter of their discontent to glorious summer is going to be the hot air furnace, and in the paper yesterday the author spoke about the backward state of the science, and surely the hot air furnace has much more need of the fostering of a Society like this than steam and hot water, for it is much more backward. Moreover, I am firmly convinced that for the ordinary residence of not more than fifteen rooms the hot air system is equal to the hot water or steam system in every respect, and superior in a great many. Now I wanted to analyze some points of the address of Mr. Jones. He seems inclined to attribute the results secured to the use of large pipes in the cellar and two registers to each pipe. I have not any doubt whatever about the success he attained. I haven't any doubt that he managed to heat that house of thirteen rooms with ten tons of coal in the coldest winter, and I think Mr. Jones will back me up in the statement that he was able to heat all the rooms at the same time, and to heat all those rooms regardless of which way the wind was blowing. That is the proposition that is the most often difficult. I am convinced from the layout of that place that Mr. Jones had no more trouble in heating the northwest room with the northwest wind blowing than a southeast room. Isn't that so, Mr. Jones?

Mr. Jones: Yes.

Mr. Thompson: At the same time I am inclined to think that Mr. Jones has attributed to the double pipe system, or the single pipe for a double register system, a good deal of the result which was due really to the very excellent system of installation he put in. To begin with he had a tremendous big furnace. He had a furnace with a 30-inch grate and with 124 square feet of heating surface. It must have been a tremendous furnace. That would be equal to an ordinary furnace drum 48 inches in diameter and 10 feet high. And that is not all. He had, if you notice, what I call thoroughfares in the furnace. He calls it an air space. That is the free passageway between the various obstructions of the furnace and the piping. The difference between the aggregate area and furnace piping and the aggregate area of all things in that casing, he had a thoroughfare of more than the total amount of all his hot air pipe. Now that is an exception. Ninety-nine out of a hundred furnaces would have about half as much space there as the aggregate area of the hot

air pipe, and that is why they fail. That is the second point wherein he succeeded. The third point was that he was liberal in his use of hot air. He used 740 inches area of hot air pipe for that house, which is at least 50 per cent. in excess of the average practice in that line. And the last point in which he was most preëminently successful was in the fact that you notice in the layout of that building that he secured a complete circulation of the air, and by that complete circulation of the air through his return flue register he overcame entirely the back pressure which arises from contrary winds. Now contrary winds spoil a furnace by creating a back pressure, and if you have got a furnace which cannot deliver or you cannot get it to deliver enough air to fill all the pipes, wherever there is back pressure those pipes are not going to be available. I have looked over hundreds of furnaces where they had difficulty and where they could not heat the exposed rooms, and in no single case did I find that they had capacity enough to deliver air enough to fill all those pipes at the same time up to their limit, and the consequence was, as soon as they got back pressure against one pipe, the law of least resistance compelled the air to take the other pipe. But Mr. Jones had air enough in his admissions, air enough through the furnace, air enough in his supply pipe to fill all these pipes at the same time to the limit of their capacity. And that was a large part of the cause of his success. Another thing that caused his success in the matter of small fuel consumption was the large quantity of air. I am glad to see he presented that point in that paper, that you cannot heat a house without air.

Mr. Jones pressed the point that the furnace must have air. Now when you furnish a certain quantity of fuel you produce so much heat, and it is simply a problem of what you do with that heat. The only way to get that heat out is by the air, and the only way to raise the temperature of your furnace to the highest possible figure is to have a sufficient quantity of air, so that the temperature of the air on the furnace will be low. If you have so little air that the air inside the furnace casing will be heated up to five or six hundred degrees it follows as a mathematical necessity that your waste going to the chimney will be heated five or six hundred degrees, while if you carry enough cold air through that furnace to keep the temperature

of the air passing through that furnace down to 200 degrees, you certainly ought not in a good furnace to have much over 200 degrees in the waste of the chimney. The lower the temperature of the air as it comes from the furnace (a deficiency in heating power made up by its greater quantity) the less the aggregate waste of heat. Now there is a point in Mr. Jones' system—while I don't decry at all his two-pipe system—I just laid out a house on precisely that plan, so I could not decry it—but I think he has failed to emphasize the most important feature in this system and the things that have secured for it such magnificent results—results which could not be surpassed by any other system of heating. (Applause.)

Mr. George D. Hoffman: I simply wish to state that I am heating my own house with identically the same plan, two registers, one below and one above, the same way Mr. Jones illustrated, and it is a success, with hot air.

Mr. Chew: I see two Mr. Hoffmans here. One has spoken. That does not answer for both. I would like to know from the Professor how the proportions that Mr. Jones has provided compare with the instructions in his course of heating and ventilation, and whether the information here is along the line that they use in instruction in the college. I think here is a chance for the Professor to discuss his paper in connection with this.

Prof. James D. Hoffman: In reading this paper the one feature that impressed itself upon me was the size of the furnace used. In all our work at the University in the designing of furnace systems and in the selection of the furnaces for the systems we have never been able to come down to the point where we could select a furnace as small as the heating men of our city have been proposing for different jobs. In our work, as in the paper just read, we figure the entire heat loss for a building, then by assuming the efficiency of the furnace at, say, 60 per cent., and obtaining the value of the coal, say, at 12,500 B. T. U., we obtain the total pounds of coal burned per hour. From this, with an estimate of the pounds of coal that can efficiently be burned per square foot of grate per hour, we obtain the grate area of the furnace. From this the furnace is selected. That is the one feature wherein we have had difficulty, *i.e.*, in making our estimate for the size of the furnace. I think in every case we have had to select a furnace which has had from 25

to 50 per cent. more grate area than has been supplied by furnace men around the country. It has occurred to me that we might be wrong, and yet from a calculation of heat losses and heat supplied we have been obliged to come to that conclusion. I was on the point of getting up a minute ago and asking concerning the best method of selecting a furnace for a certain place. What would be your method of determining this? Would you take it from the grate area, from the heating surface, or from the volume of air delivered by the furnace? I don't know that Mr. Jones made the statement, but at least the inference you would draw from his paper is that a part of the success of the plant was due to the fact that he selected a large furnace and had a large grate area. Now that is just exactly in accord with the results of our work, and I can only commend him on that point. It bears out our work and makes me more confident that we are on the right track.

Mr. Chew: I think Mr. George D. Hoffman can satisfy Professor James D. Hoffman there, and I hope he will say a little more on the furnace question than he has said.

Mr. George D. Hoffman: I think there is one thing in furnace construction that has been lost sight of by the furnace manufacturers, and that is the fact that hot air always travels upward in an absolutely straight line. You will find that fully 50 per cent. of the furnaces that are to-day on the market are constructed with the fire pot tapering outwards and the combustion chamber tapering in. The air travel in the first place is deflected by the taper of the fire pot outwards, and the hottest part of the furnace is immediately over the fire, and in the combustion chamber those lines are carried right away from the line of air travel. The result is that, as the air cannot be heated except by contact, and as it wants to go straight up, it must be deflected in some way and pushed over against those surfaces. My contention has always been in the construction of a furnace that it should be made—and that is equally true of a steam radiator or anything of that kind—that it should be made with the line of the heating surfaces perfectly parallel to the direction of the air travel, and that is the whole solution of a properly constructed furnace. I think our President here will bear me out in the statement that that is the fact. There is another phase in my furnace experience. I have been called a crank

on the subject of a steel plate furnace. I have always contended that the fire was the source of all the heat in the furnace, and consequently that, as the fire was the source of the heat, the less resistance that we would get between the fire and the air that we were trying to heat by the fire, the better results we were going to get. In other words, a great proportion of heat transmission is lost in the thickness of the iron and the air does not get it at all. In the proper construction of a furnace there is another thing that is very frequently lost sight of, and that is the fact that it requires a certain mixture of air with the gases that are given off in order to permit thorough combustion. You have got to mix the air with the gas and then bring that mixture of gas and air in contact with flame if you are going to have perfect combustion. Now the ordinarily constructed furnace does not have a sufficient combustion chamber in a great many cases. The result is that the gases are forced off into what they call the radiator, and then passed from the radiator into the chimney without combustion at all. If a furnace is constructed in such a way that it has a large combustion chamber, so that a certain amount of air can be mixed with those gases that are given off, you will get perfect combustion inside of the combustion chamber of the furnace; and the small drum which passes around the furnace is simply for the purpose for which it was intended, that is, simply to bring the air in contact with the hot gases and cool them before they pass to the furnace. As Mr. Thompson stated, what you want to do in furnace heating is equally true in steam and hot water, namely, to bring the greatest amount of air that you can in contact with your heating surfaces. The same thing is true of a properly made radiator.

It is a vital question to every one interested in heating to get the most we can out of the fire. The way we can get the most out of it in steam heating is to get the greatest possible condensation of our steam, and in hot air heating to get the greatest amount of air in contact with the hot surfaces of the furnace.

Mr. Blackmore: There are one or two statements that Mr. Hoffman made that I do not think ought to go unchallenged. That is regarding the conducting power of a furnace. Professor Carpenter has made some experiments that show that all the heat that is being taken off by contact with either steel or

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cast iron in any thickness up to three-quarters of an inch will be conducted through more rapidly than the air can take it off by contact. Therefore it is the experience of all the authorities that I have heard of in making these experiments that within reasonable thickness the conducting power of any metal is quite sufficient to conduct the heat through as rapidly as the circulating air can take it off, even under forced blast conditions. I think Professor Hoffman could probably explain this in better language than I have done. He might give us a few remarks on that subject, just as he would explain such a matter in his class.

Professor Hoffman: I think I have nothing further to add. It is something that I would hesitate to make any definite remarks upon without giving it further consideration. I think there is a good deal that can be said upon both sides of that question.

The President: You have never actually tested the subject?

Professor Hoffman: You mean the passage of heat through the metal? No, I have never made any definite experiments in that line.

Mr. Chew: When I was connected with a furnace concern, we undertook to sell to a trade in a district where they insisted on having cast iron construction, and a large portion of the structure we were selling was sheet steel, sometimes 18, sometimes 16 gauge, so you see it was not very heavy, and to suit the demand of this trade we took off the superstructure of steel and put in place of it a cast iron structure. That exposed approximately the same amount of surface, if anything there was a little more, and it reduced the heating capacity. The fire pot, grate, the casing and inner jacket, and all other portions of the furnace, were exactly the same, but when we put the cast iron radiator in place of steel we reduced the heating capacity of the furnace more than 20 per cent.

Mr. Jones: I would like to make a remark in defense of the article read a few minutes ago. Mr. Thompson, of Springfield, makes reference to the success obtained from the system described in this particular heating plant in Battle Creek, which we have referred to. While it is true that the large furnace and the large amount of air were factors in the successful operation of this plant, I wish to bring out the fact that there was but half the number of warm air conductors conveying that

heat from the furnace to the rooms being heated. There was less loss of heat in the cellar from friction and radiation, which can be obtained by the two registers on the one pipe or the two rooms, one on the first floor and one on the second floor, being heated from one supply pipe. I have come to that conclusion after experimenting along that line for a number of months through the heating seasons, and I wish it understood that a reasonable amount of credit for the success of this particular plant is due to the fact that the air was conveyed through a fewer number of large pipes than commonly used.

Mr. Chew: I hear the question asked as to how the ventilation was done, and it goes along with the topic that was under discussion at the annual meeting. I forget what the topic was in words, but it was approximately, " Is it possible to provide some practical method of ventilation in dwelling houses? " As Mr. Thompson has said, the most important heating work is not the heating of buildings that have $10,000 heating plants, with fans and high pressure apparatus, but heating the homes where the people live, and the ventilation of homes is left to men who run tin shops down in the cellar on the corner somewhere, who are at the mercy of some manufacturer; who, according to Mr Hoffman's experience, recommend a furnace 25 per cent. smaller than he finds is theoretically correct. Consequently those men cannot uplift the cause of ventilaion. They have very little influence with architects, builders or customers to induce them to spend some money for ventilation. I have found that you cannot get two things in the same place at the same time, and the air that is already in a building has got to get out before the fresh, hot air comes in. This piping system here mentions a double stack. As a rule that is for fire protective purposes, and they don't take the air to keep the inner stack cool. This specially constructed furnace has a line of pipes near the floor taking the air out of the room to make room for more hot air to come in, and we all know that a very small steam jet will induce a pretty lively movement of some other liquid, and the exhaust of a small quantity of air exhausted by this double stack will make room for more air to come in. It will induce a more lively change of air than is provided in the furnace system as ordinarily installed. I think that is a very important part of this system. I know very often when a room

cannot be properly heated it is because it is almost impossible to get enough warm air into the room to heat because there is no provision for air to get out. A very small outlet for some of the air in the room will let the air flow in enough to change the temperature. And another advantage which this or any other air or indirect system has is that you cannot heat the room to a comfortable temperature, according to a statement by Mr. Jellett, without changing the air about four times an hour, which is a strong recommendation for the indirect heating systems.

In answer to a question by Mr. Berry Mr. Jones said:

Mr. Jones: The air in this particular case is drawn out of the rooms through the ventilator which is provided at the bottom of the register, where the air passes out of the register into the space between the inner and outer casing, and from there it passes upward, either around the wall pipe or in the space between the inner and outer casings of the double wall pipe, and between the studding to the attic, and from there is conducted to the chimney. This house that we speak of is not provided with fireplaces. A fireplace makes a splendid ventilator for a residence heated with warm air. By referring to the sketch you will see that there are five outlets for air to be taken out of the building; this air is conveyed to the main air duct, and is used only during the night when the fire is allowed to run low or between night and morning. The air is taken from the house back to the furnace and circulated until morning, when the return ducts are supposed to be closed, and air taken from the outside, and the only ventilation in this particular case is through the register. According to the rules that have been followed in regard to ventilating rooms of this kind, this amount of ventilation would appear inadequate, because the outlets are small as compared with the inlets, but the fact that this particular job does work successfully is evidence that what Mr. Chew has just said is true, that a small constant outlet increases the circulation. The change does not take place four times an hour. I doubt if it takes place more than four times a day; but, of course, at night, when the inside air is used, the change takes place rapidly and constantly. But ordinarily in installing warm air furnaces where a ventilating flue is supplied I have followed the plan of taking air out of each room, the same amount as is

brought in. This is conveyed through different conductors to one main duct, which is connected both with the ventilating stack and with the bottom of the furnace, supplied with a valve so the air can be turned from the furnace to the ventilating stack when outside air would be used to supply air for heating. During nights when the fire is low, or whenever it was found necessary to do so, the air from outside could be cut off from the ventilating stack and the inside air would be used for supplying the furnace, causing this air to pass from the rooms to the furnace and through the furnace to the rooms again. Of course in time the air would become foul by being heated and heated over and over. Not so much so as in a church or a school room, where there are more occupants.

Mr. Chew: I think it is due to Mr. Jones to explain that it is not customary in our Society to move a vote of thanks to a member or any one else who favors us with a paper. The only evidence of our good feeling is the appreciation of the audience, and he has certainly seen that his paper has been received with great interest, and the discusion of it cannot fail to be of value to all present. The publication of the paper and the discussion of it will contribute substantially to the literature on this particular line of work. For the benefit of all here I want to say that this paper was prepared by Mr. Jones in response to a request.

Prof. R. C. Carpenter: I have also attempted to work out a scientific method of proportioning the flues in a furnace heated house, which has been published in the fourth edition of my work on heating and ventilating, pages 315 and 330. The method used was as follows: Let F = square feet in grate, C = weight of coal burned per square foot per hour, r = heat units per pound of coal, E = efficiency of furnace, h = total heat units given off from furnace per hour, T = temperature of air leaving furnace, t' = temperature of outside air, t = temperature of room, G = area of glass and outside doors in room in square feet, W = exposed wall surface in square feet, H = heat lost in room per hour, K = cubic feet of air heated by furnace per hour, K′ = cubic feet of air required to warm the room. Assume 60 cubic feet of air warmed one degree by one B. T. U., which is very nearly correct we have the following formula:

$h = C\,F\,E\,r$ = total heat given off by furnace per hour. (1)

$$K = \frac{60\,C\,F\,E\,r}{T - t'} = \text{cubic feet of air heated per hour by furnace.} \quad (2)$$

$H = (G + \frac{1}{4}W)\,(t - t')$ = total heat units to warm the room. (3)

$$K' = \frac{60\,(G + \frac{1}{4}W)\,(t - t')}{T - t} = \text{cu. ft. of air to warm the room.} \quad (4)$$

For the average case we will assume

$T = 120°$, $t = 70°$, $t' = 0°$, $E = 70\%$, $r = 13{,}000$ B.T.U,

$E\,r = 9{,}100$ B.T.U.,

and we have

$$h = 9{,}100\,C\,F. \quad (5)$$

$$K = 4{,}550\,C\,F. \quad (6)$$

$$K' = 84\,(G + \tfrac{1}{4}W). \quad (7)$$

$$H = 70\,(G + \tfrac{1}{4}W). \quad (9)$$

Since the air heated by the furnace must warm the room

$$K = K',$$

from which

$$C\,F = \frac{G + \frac{1}{4}W}{54.2}.$$

If 3 pounds of coal be burned per square foot per hour,

$$C = 3,$$

which substituted in above gives

$$F = \frac{G + \frac{1}{4}W}{162.6}. \quad (8)$$

If the area of the grate be expressed in square inches F′ we have

$$F' = 144\,F = \frac{G + \frac{1}{4}W}{1.13} = .885\,(G + \tfrac{1}{4}W).$$

If the coal consumption were $3\frac{1}{3}$ pounds of coal per square foot of grate per hour the required grate surface in square inches becomes very nearly

$$F' = 0.8\,(G + \tfrac{1}{4}W). \quad (8a)$$

In order to find the cross section of the leader or hot air pipe to any room denote the area of the flue in square inches by L, the velocity of the air in feet per second by v, in which case the cubic feet of air passing through a flue with a section of 1 square inch will be $25\,v$ per hour.

We will then have

$$L = \frac{K'}{25\,v} = \frac{84\ (G + \frac{1}{4}W)}{25\,v} = \frac{3.36\ (G + \frac{1}{4}W)}{v}. \quad . \quad (10)$$

The value of v will depend upon the friction in the pipe, which in turn depends upon the length of pipe; it will also depend upon the temperature and difference in heights. For special cases v could be computed, but as the hot air pipes are generally of short lengths I have assumed as sufficiently accurate for most purposes the following values:

For the first floor

$$v = 4, \quad L = \frac{G + \frac{1}{4}W}{1.19} = \frac{G + \frac{1}{4}W}{1.2}, \text{ nearly.} \quad . \quad (11)$$

For the second floor

$$v = 5, \quad L = \frac{G + \frac{1}{4}W}{1.53} = \frac{G + \frac{1}{4}W}{1.5}, \text{ nearly.} \quad . \quad (12)$$

For the third floor

$$v = 6, \quad L = \frac{G + \frac{1}{4}W}{1.78} = \frac{G + \frac{1}{4}W}{1.8}, \text{ nearly.} \quad . \quad (13)$$

From these formula I have deduced the following practical rules for furnace heating, calling in every case $G + \frac{1}{4}W$ as the equivalent glass surface:

First. To find area of grate in square inches, *multiply equivalent glass surface by* 0.8.

Second. To find area of flue leading to any room in square feet, *divide equivalent glass surface by* 1.2 *for the first floor, by* 1.5 *for the second floor, and by* 1.8 *for the third floor.*

Third. Make area of cold air supply 0.8 of sum of sections of hot air flues.

Fourth. Take area of chimney smoke flue as $\frac{1}{12}$ that of the grate, with allowance of one-half inch per side for friction.

I have found these rules to give good practical results. I believe that the accuracy of the work would be greater if accurate values for the velocity of the air passing through the flue were computed for each case as was done in the example cited in the paper. It strikes me that a more simple way to obtain the area of the hot air pipes would come by computing the area in each case for a certain velocity, as for instance 3 feet, and multiply this result by the factor needed to make correction.

Thus, for a velocity of 3 feet per second, the area in square inches of the hot air pipe is

$$\frac{G + \frac{1}{4}W}{1.2} = L.$$

This result should be multiplied by the following factors for other velocities as shown below.

Velocity Ft. per Second.	Factor.
1	3
2	1.5
3	1.0
4	0.15
5	0.6
6	0.5
7	0.43
8	0.375
9	0.333
10	0.3

CXXXIII.

TOPICAL DISCUSSIONS.

TOPIC NO. I.

" Are the commercial demands upon the time of our members the only hindrance to the presentation of tabulated or descriptive experience of their work?"

DISCUSSION.

Mr. Frank K. Chew: Mr. President, the Secretary is looking over my way. When the time comes to make up the programme for the annual or the summer meeting, it requires quite a little chipping in to get the necessary papers and new topics. The result is that I have helped the Secretary to prepare the list of topics. There certainly is somewhat of a scarcity of papers on subjects that some of the men would like to have discussed here, and this topic was presented with the idea of inspiring the members to send in more papers or more topics for the meetings. Is it a fact that the commercial demands on your time are so great that you have not time to tabulate your work or save a set of plans and dictate to a stenographer an account of what you have done? When Anders Reck came from the other side of the ocean to talk about his system, he was thoroughly posted on it, and the cross-examination he had was one that would make many a man back water, but he came out tip-top, and I am sure that any man who has installed a plant would come out as well as Mr. Reck did. His example can be followed with advantage by other members.

TOPIC NO 2.

" Vacuum Systems of Steam Heating."

DISCUSSION.

The President: There are quite a number of vacuum systems in the market, and we are not here to exploit any one particular system nor to advertise any one particular system; but we

are here to get the best results from each of the systems known. If any gentleman represents any vacuum system here this morning, we will be glad to have him give us anything that he has to offer on this subject.

Mr. E. K. Munroe, of Baltimore: There is a question I would like to ask in regard to vacuum work, and that is, Does an ejector satisfactorily operate as a relay for a second pump to maintain a vacuum in a first-class manner, or does it maintain sufficient vacuum to make a Webster heating job work? I am about to install a job in which one pump and one ejector are specified. Now if anything happens to the pump and we have to fall back on the ejector, I have not had sufficient experience to know whether it would operate. I have always had two pumps on every job that I have had to do with. I would like to be informed on the subject.

Prof. James D. Hoffman: I have not any real reason to offer the gentleman as to why that is done. In fact, I am rather surprised it was done. I have come in contact with a number of jobs with the Webster people, and in no case have I had anything but a duplex pump. I mean a double pump. For my part I should rather prefer the two pumps to the one pump and ejector. That would be my impression.

Mr. E. K. Munroe: I would say further, regarding the subject, that the last thing I did before leaving Baltimore was to make arrangements to install in this particular job two vacuum pumps to complete the system. Not that I was afraid that the ejector would not work, because the proposition from the Webster people covered the one pump, but failed to say anything about the ejector. The specification from the engineers, Messrs. Newton & Painter, of Baltimore, specified one pump and one ejector. I would not have insisted on two vacuum pumps had I known positively an ejector would do the work. There is another job in Washington that I have received plans for, which probably will go through with a pump and ejector, because I don't propose to take up the matter the second time, but will leave it to the engineers of the Warren Webster people who prepared the plans. In the first instance the Warren Webster people did not prepare the plans.

The President: Might not the ejector be intended for an auxiliary?

Mr. Munroe: Yes; it is a relay. But the point is, will the ejector sustain 16 inches or more of vacuum on the system when it is being used in the place of a pump, which would positively do so?

Mr. A. T. Hoyt, of Warren, O.: I have had a little experience with vacuum heating which may be of interest to the Association. I am a florist by occupation, and my experience is in greenhouses. They are a little harder to heat than houses. I have run with vacuum steam and also vacuum water, and have had three or four years' experience in the two. I found that vacuum steam is superior to steam heating in greenhouses, for the reason that it does not take the fuel or the watching that a steam plant does, and it is very easily managed, from the fact that all you have to do is to have your piping right and then regulate your fire. When the weather is mild we have a low fire, and we have heat in the pipes that you cannot distinguish from water heating, and by regulating the fires it can be reduced to probably 100 degrees. It saves fuel and saves attention. I have left it from 9 o'clock at night until 4 o'clock in the morning, on cold nights, and had heat in my house and greenhouses in the morning, although the fire in the boiler needed kindling before I could start it up with coal. If I had had steam heating I would not have had any heat at all. To test the thing, I went out at 4 o'clock in the morning and broke my vacuum and let the air in, and had to fire up for an hour or two and force the air out, whereas if I had put a fire in when I got up and left the valve closed I would have had heat all the while.

Prof. J. D. Hoffman: Might I ask this gentleman whether he uses a pump? How do you get your vacuum?

Mr. Hoyt: I get the vacuum by firing and forcing the air out of the pipes, and then I have an automatic valve that closes, and no air gets back into the pipes; and if I don't fire strong enough to produce 212 degrees, then I am under a vacuum, and get down as low as 100 degrees.

Mr. John S. Brennan, of Milwaukee: I would like to ask how you get your vacuum in hot water?

Mr. Hoyt: By the contraction of the water.

Mr. J. J. Blackmore: That is a somewhat interesting problem, and I don't think many of us have got it through our minds

yet. It appears he forms a vacuum by heating the water in the system and then making the system airtight, so that when the water cools and shrinks there is a vacuum made. Usually that vacuum in a hot water system appears in the form of an air trap. Now if the water circulates at a low temperature our friend has discovered something that I think has not occurred to many of us, viz., that an accelerated circulation in a hot water system can be produced by what he calls a vacuum. He expands the water, then closes the system tight, and lets the water cool. Now there would be a vacuum there, but how much it affects the circulation of the water could only be determined by experiment. I would like to ask Mr. Hoyt how low he allowed the water to cool down and how rapidly it circulated. He spoke about opening a faucet and letting the air in in one case, and it took some time to heat up. I would like to have some explanation of the difference, and whether he tried it more than once. Also I would like to know if there was anything in the nature of a tank where he held this so-called vacuum; or whether the system was a pressure hot water system with an expansion tank.

Mr. Hoyt: As near as I can remember, I will try to answer your questions. My piping is the same as an ordinary hot water heating plant, but instead of an expansion tank I have two 20-foot four-inch pipes placed probably four feet higher; I fill my pipes, and then when I expand my water it fills those four-inch pipes—probably forty feet of four-inch pipe. At the end of that I have an automatic valve; it is a union, a half-inch union, with a solid gasket, and that is screwed down just tight enough so that it will leak from pressure; and then when the water expands it sometimes forces the water out of that valve. If it leaks, I have a tank to catch it in, so it doesn't do any damage. Then when the water contracts, or I draw water out below, that valve will close, and then I am under a vacuum anywhere as low down as water getting cold will make it. I have had it so low that no water would come out of the bottom. I have no way of testing exactly what vacuum I have, but I could get no water out of the radiator in the house, nor out of the piping in the greenhouse. To further test it, I get up about 4 o'clock in the morning to watch my fire, and have found the radiators in the house hot after leaving the fire at 9 o'clock at night.

Sometimes I found fire enough so that I could rebuild it with coal; other times I have to rebuild it with kindling. I fire up until in a short time my radiators show increased heat, and the radiation in the greenhouse shows increased heat, and if I fire strong enough, I have that valve leaking; that destroys the vacuum. Sometimes I would turn the pet cock and break the vacuum; then I would have to fire quite strong before I got the heat again. I am only giving my experience; I can't tell why these things are.

Mr. J. J. Blackmore: Will you explain how long it took to circulate when you let the air in, and then about how long it took to circulate when you took the vacuum in.

Mr. Hoyt: Just as long as it would in an ordinary hot water apparatus.

Mr. Blackmore: Well, what was the difference in the two?

Mr. Hoyt: Why, in the one case, when I did not break the vacuum, just as soon as my fire got to burning the circulation increased right away, and I soon had it hot. The other way I would have to get a hot fire and fire quite strong before I could produce the same heat.

Mr. Blackmore: Would there be a difference of an hour, say?

Mr. Hoyt: Yes, easily an hour.

Mr. Blackmore: Now one point more: Did you ever try the difference in the temperature between the flow at the boiler and the return come-back to see the difference?

Mr. Hoyt: You cannot do it when you have a vacuum. You cannot get any water out anywhere.

Mr. Blackmore: But you could have a thermometer. Have you ever tried it?

Mr. Hoyt: I have no hot water thermometer.

Mr. Blackmore: Could you tell approximately by feeling it how much difference there was?

Mr. Hoyt: No, I could not tell that. I intend to put on a hot water thermometer.

Mr. Blackmore: It would be very interesting to have that put on and try the temperature under the various methods.

Mr. Hoyt: I intend to do that this summer, but I was just running the greenhouse for my own profit, and did not care to enter into the scientific points of it, but it saves me fuel at both ends of the system. In the morning in firing up I don't use so

much fuel to get heat, and at night it lasts longer. Last March I put on a fire one day and went to Cleveland and was there for two hours, and when I returned home I found everything was all right, and there had been nobody to look after it whatever.

Mr. Blackmore: That would not be at all conclusive. A good hot water heating apparatus would produce exactly the same results. The question is now raised that a vacuum in a hot water system does accelerate circulation. What I am trying to get at is why it does. If it does, it is a new principle we have not yet investigated. We know that a hot water job in an open tank system will circulate more at some times than at others. It may be due to good or bad drafts in the heater, to a clean or a dirty fire. I don't want this idea to be dropped; I want to see it investigated to a finish. Nor do I want our friends to go away with the idea that it is not practical. It is a new idea that one can use a vacuum in a hot water system. We know we can get it, but we don't know, or I don't know, that it will accelerate the circulation. I cannot see yet how it will do it, but it is worth while to give the subject a good deal of investigation.

Mr. Brennan: If I understand the gentleman right, he says he has two lengths of four-inch pipe, that gradually fill with water by increasing the heat in the furnace, and after the water comes to a certain point he closes that air valve, or union, or whatever it is, and my idea is that he has simply a closed system of hot water heating. Am I right? I don't see that there is any vacuum to that, and I don't see that he would get any circulation any quicker than he would on a closed system. He may heat his fire, and he may heat it to a higher temperature than he would if he had an open system; consequently he would get more heat in his fire. But from what the gentleman says I cannot make out where he gets his vacuum.

The President: He says he lowered the temperature of his fire.

Mr. Brennan: Yes, but I can't see that he saves anything by that. When he makes the second fire he is where he was in the first place. That is the way I understand it.

Mr. Blackmore: There is undoubtedly something in that. The moment you raise steam in a vacuum, the steam is drawn

toward the point of least resistance, which is the point toward the vacuum. Now if you can produce a vacuum in a hot water system, say, at the upper portion of it, undoubtedly when the particles of that water begin to flow, it will flow toward that vacuum. Just to what extent it would do so is an interesting point, but I do know this, that if we can get the hot water at the top it will flow down quick enough when it cools, and it may be our friend has stumbled on a principle that we can afford to investigate. Why should not the circulation be quickened in a fluid like water as well as a fluid like steam? They are both fluids, one more dense than the other. But there is a movement of the particles themselves, and, while it never occurred to me before, I believe it would flow toward the vacuum at an accelerated speed. It is a subject I would advise the members to give a great deal of thought to, so that we can drop it if there is nothing in it, or carry it through to its conclusion.

The President: You say you open a valve. When you open that valve, doesn't that allow the air to go in?

Mr. Hoyt: It does, and you can hear it as far as from here to the end of this room.

The President: Then if you allow the air to get in, where is the vacuum?

Mr. Hoyt: Letting the air in breaks the vacuum.

The President: Then when does it work best, when the vacuum is broken or when the vacuum is in action?

Mr. Hoyt: Then I am down to an open tank system of hot water heating when I break the vacuum.

The President: Which is the most economical?

Mr. Hoyt: The vacuum system. I can run all day long, and you can't get a bit of water out of the system anywhere.

Mr. Munroe: I imagine that he has his pipes arranged in such a way that when he breaks the vacuum he creates an air pocket, and that is the reason for the difference in rapidity of circulation, but I don't see that anything would be gained. It is only a quicker circulation in flowing. I would like to ask if that pipe is run horizontally or vertically.

Mr Hoyt: Horizontally, one pipe above the other.

Mr. Munroe: There it is, I think. The top pipe becomes empty and it won't flow over on account of the grade until the water is sufficiently expanded to overcome the air pocket.

When that air pocket is overcome you get the circulation you cannot get otherwise, and there is absolutely nothing gained except that you get a circulation immediately when you have a vacuum, as you call it, because the heating of the water helps to lift the water over the high points more quickly than in the other cases.

Mr. Brennan: I have one of Mr. Hoyt's cards here that a member has handed me and on the back of it is a diagram of his pipes. If we had a blackboard, possibly he could describe this piping. I really don't understand it.

The President: It would be a little difficult to get at that, I think, because the gentleman has no real data to go by. Mr. Munroe, if you have sufficient data to explain this we will let you explain what you understand from Mr. Hoyt's plan and system.

Mr. Munroe: I feel something like a man who has an elephant on his hands because while it is clear in my mind that the circulation will be attained rather more quickly yet just why that circulation is caused I cannot explain, unless it is due to the fact, as I have said, that the vacuum that there is in the pipes assists the boiler in lifting the water over this high point. If that is the case, that explains it; but does that occur? I think from this document that we have here and the sketch that Mr. Hoyt showed me of this apparatus that there is a short circuit which would take away the attempted explanation that I gave a while ago. I think it is likely that the short circuit would overcome the shortage in heat units given out by the furnace, because the apparatus should start immediately through this short circuit. In either case, if he had no short circuit, then I could readily see why the vacuum would assist the boiler to lift that water over the high point and start up the circulation. But he assures us that the circulation is more rapid when he does not break his vacuum. He says he saves an hour in attaining a good flow or a good circulation. I am unable to explain the condition from the sketch that I have here, which a good many of you have. The four-inch pipe in my mind acts as a closed expansion tank, and I cannot see why that circulation should not begin immediately when he begins to fire.

Mr. Brennan: If I understand him right, he builds a fire in his heating apparatus, and the circulation does not commence

until after the water is all heated, until it makes the passageway between the upper pipe and the return pipe, or, in other words, the same as a steam heating apparatus, by going around and shutting all the radiators off and getting the steam up in the boiler and opening up the radiators and letting the steam pass through. I cannot see that he gets any more circulation. He gets more rapid circulation after he has made the connecting link on the return pipe at the top of the system instead of the return pipe at the bottom of the system.

The Secretary: I would like to say a word or two on that subject. I have noticed in hot water apparatus in cooling down that if one line were connected to the expansion tank on an open tank system and the other line were bottled up, as it were, that the circulation would continue longer in the line that was bottled up than it would in the line to the expansion tank where the vacuum conditions did not exist. It is not a new thing. I think in 1880 Baldwin, in his book on steam heating, illustrates a radiator set on the floor above the boiler, in a steam heating apparatus connected below the water line, and that has been described as going on circulating long after there was steam in the boiler, long after there was any pressure on the boiler. When there was a vacuum in the boiler, the hot water radiator, some five or six feet above the boiler, continued to circulate in this vacuum. The water was held in suspense in the radiator and could not return to the boiler on account of the air valve being closed. It has been known and practiced for years, though not in the way Mr. Hoyt has done it. This arrangement Mr. Baldwin described accomplished exactly the same thing, only he had hot water circulating above the water line from a steam boiler.

Mr. Munroe: There is only one thing I left unsaid. I cannot see where any saving in fuel would be attained, because if he does not give up a certain amount of heat for the water to boil, he does not have that heat to give out when he comes to the greenhouse. In each case he would have to inject so much heat into the boiler. He can only give out as much as he puts into the boiler.

The Secretary: The saving would be in allowing it to run longer at a lower temperature if you did not require a higher temperature. That is the principal advantage of hot water heat-

ing, that you can heat to a lower temperature when you only require a lower temperature, and do not wish to maintain the intense heat of steam.

Mr. Smith: Mr. Munroe says you cannot get out of the radiator any more heat than you put in the boiler, but it is possible you might get out considerably less if you were working at a disadvantage and had friction.

Mr. W. R. Stockwell: I understand that the gentleman lives very near Cleveland. If there are any members of the Society who are interested in this and live near Cleveland, would it not be well for them to examine his plant and make a report at the next meeting.

The President: I think that is a very good suggestion. I think it would be a very wise thing for some gentlemen living near there to go and see this apparatus and see if there is anything new in it. That is what the Society is for, gleaning information wherever it can be found, no matter whether we get it from a saw-mill or a greenhouse. We want the very best that we can get.

TOPIC NO. 3.

"How and to what extent, if at all, can the effect of humidity upon the sensible temperature of a room be modified by ordinary heating and ventilating apparatus?"

DISCUSSION.

Mr. Frank K. Chew: I think this is an interesting subject, and I will again describe an experiment which I conducted in my own house, heated with a hot air furnace; sitting in the evening reading I felt chilly, the result of the natural moisture of the body being evaporated more freely than it should from the excessive dryness in the air. I looked at the thermometer and saw it was up to 83 or 84, and decided that the temperature was high enough; but there was something wrong. I got a tin pan about four inches wide and three inches deep and fourteen inches long, and placed that on the top of a floor register near the baseboard and bent a wire so as to form a rack, and hung a towel on that so that the towel ran down into the water and acted like a wick in a lamp. As the hot air came through the register it absorbed the moisture from the towel, and I could

read more comfortably, and the plants growing in that room thrived better than they did before three pints of water a day was evaporated in the room. In one case I felt cold with the thermometer above 80. Under the other conditions I felt comfortable with the thermometer down around 70. So that it shows in my experience and in my belief that in many cases the trouble with heating apparatus is due to the lack of a sufficient amount of moisture in the atmosphere to provide that condition which we claim is normal. Some of the rest of the members may have similar information to give, or something from their own experience. I have read the descriptions of blower systems where they went to considerable trouble to wash the air and dry it and humidify it before it was driven into the building, showing that the engineer and the people for whom it was designed both appreciated the necessity of a little more moisture in the air than is blown into a building under artificial conditions. I believe that in the winter season many houses are not as comfortable or as healthy as they would be if the atmosphere had a greater percentage of humidity.

Mr. Smith: I should gather that most of what Mr. Chew has said is assumed in the question, because it says, "The sensible temperature," which is precisely the difference between a moist and a dry temperature. The question seems to be more particularly directed to a discussion of how that can be accomplished by ordinary and simple methods instead of by an elaborate humidier and humidistat contrivance. Those, of course, are desirable, and are used in places where the health of the people is of enough importance, or where a manufacturer has to maintain a constant moisture, for cigars, for instance. But for ordinary residences the thing is just as desirable as Mr. Chew states. Cannot anything of that kind be accomplished by means less primitive than Mr. Chew's wet towel, and a little less expensive than the humidistat?

Mr. William W. Macon: As a guest, I would like to ask if some of the members have not read perhaps more carefully than they had at the time of the last meeting Professor Carpenter's paper, in which he gave results of experiments that were made in Nebraska? The impression that I got from those experiments was this: that while there was a difference in the humidity in the house of this weather observer where he employed a

moistening apparatus, as compared with a house exactly similar, or the other half of his house, the difference was not very great. Moreover, the amount of water was very large. The impression that I got was that there was not as much advantage from putting moisture into a house as there seemed to be theoretically, or as you would imagine you ought to get theoretically.

Mr. R. Collamore, of Detroit: I don't know that I can answer the question that has been propounded here directly; but I thought perhaps you might be interested in a trial of humidity that was made in a school in this city. It was decided to install a system to control the humidity in this school, as a matter of experiment. The fan in the school building is of the double discharge type, and a humidifier was placed in each discharge of the fan. It was found by experiment that a humidity of forty was the most desirable. We were under the impression that a humidity of 50 to 60 would be more desirable, but when we had a humidity of 50 to 60 we found that moisture was precipitated upon the windows and the blackboards, and therefore we reduced the humidity until we found the point where it would not be precipitated. When the humidity was as high as 50 we also found that the atmosphere of the rooms had a depressing influence upon the pupils, similar to what we experience from a so-called "heavy day" in summer. But when the humidity was reduced to 40, we found the results very good. I cannot give you as yet the effect of the humidity upon the pupils, although we expect to find that out during the coming year. The main point I had in mind in speaking was that the best point at which to maintain the humidity seemed to be 40. One other difficulty that we experienced with this apparatus was that we could not get a uniform humidity in all the rooms, due, no doubt, to the fact that we only had one humidifier for six or eight rooms. It seemed to demonstrate the fact that in order to maintain a uniform humidity in every room it would be necessary to have a humidifier in each individual flue leading to the rooms.

Mr. Frank K. Chew: Can you give any idea of the amount of water that would be evaporated in that connection?

Mr. Collamore: I cannot, because we gave up the idea of the water pan and used steam jets. We did start to use a water pan

with steam coils, and found that we were unable to get enough water by that method, due, no doubt, to the fact that our pans were not large enough, and it was a very simple matter to use steam jets, so we used steam jets and regulated the pressure until we found the point that gave the best results.

Mr. Macon: I would like to ask if you found any unpleasant odor due to the steam when you injected the steam instead of using the pan?

Mr. Collamore: I noticed no objectionable odor, and I might say in this connection that probably the only way you would get objectionable odors would be where the water in the boiler was contaminated with oil brought back in the returns; but in this plant there are no returns containing oil brought back to the boiler, and the city water is reasonably good, so this probably accounts for the fact that there was no odor.

Mr. Feldman: I would suggest that the Chair ask the gentleman to report next winter some more data in connection with those experiments to the school. It is very interesting.

Mr. Munroe: Regarding the question, "How can this be attained by an ordinary heating and ventilating apparatus?" if by an ordinary heating and ventilating apparatus is meant "direct radiation," I would say that there can possibly no change be attained. I don't know that this can be gainsaid. There is a widespread idea among people generally who are not acquainted with steam heating, hot water heating and stove heating, that a great deal more moisture is developed by hot water than by steam radiation, and a great deal more moisture from steam radiators than from a coal stove. That idea is erroneous, of course, but it is the general impression among people who are not in the heating business; that is something we have to explain often.

Mr. Frank K. Chew: A while ago I read an article in which the author described how the tea kettle over the open fireplace gave a certain amount of moisture in the room, and when we departed from the open fire and the tea kettle to the plate stove, the tea kettle still did service, and later, when some other type of heating stove was devised, an urn to hold water was put on the stove. In some stoves they surrounded the stovepipe with a specially constructed vessel, so that the moisture came from that; then, as we progressed to central heating plants located

down cellar for heating each room, such as hot water and steam, little tanks were made and hung on the coils, and later, when the radiators were built, very thin vessels were made to hold water, and they were shoved either in between the radiator and the wall or between the two columns of the radiator. That was the custom several years ago, but in our progressive advancement we have turned our backs on some of the good things our grandfathers knew about, and now no method of providing moisture is provided in the direct system. With direct radiation a humidifying apparatus that is very simple can be provided.

Mr. E. F. Capron, of Chicago: I think the statement was made that there was hardly any difference between a steam plant and a water plant as far as the humidity was concerned. I don't just agree with that. I had occasion last winter to install a hot water plant where we had a tempering room and indirect hot water on the first floor throughout. The owner of the residence had previously lived in a steam heated residence—indirect steam—and he told me one morning that he noticed the flowers in the room remained fresh much longer than they did in his old house, and he asked me why it was. I explained to him the arrangement of the system that we had installed, and I really believe it was on account of the water indirect system, and that the air was not so dry as it was in the steam plant.

The President: Were there any leaks in the water pipe?

Mr. Capron: No, sir. The system was not filled from one week's end to the other. The system was absolutely tight. We had a large tempering chamber, with a good-sized opening of fresh air to it before passing to the separate indirects, etc., and in visiting residences with steam and hot water plants I have noticed a great deal of difference in the air in these places. The air in buildings with the steam plants seemed to be oppressive and unsteady, while the hot water plants have been more of an even temperature.

Mr. H. A. Smith: I would like to ask, if no water gets out of the hot water system, how does it impart any moisture to the air?

Mr. Capron: I don't think there is any more moisture in the air than with steam heating, but we don't heat the air to a temperature that a steam heating plant will.

Mr. Smith: It is not a more moist air, but simply a lower temperature.

The Secretary: I have heard the question asked and answered a number of times as to whether hot water heat is more moist. Some contend that it is and some that it is not. My experience is this: that there is a certain amount of humidity in the air. Steam heat, at one pound pressure, will extract a certain amount; water at a much lower temperature will not extract as much, and when you want to dry lumber you raise fifty pounds pressure or more. They are removing some of it at five pounds pressure, but the only advantage of hot water heat over steam is that it does not extract so much natural moisture from the air as a steam plant at a higher temperature would. In heating greenhouses they put evaporating pans on the pipes so that they will pass moisture into the air. In some of our office buildings I have known of people who have done this: taken a water pan one inch deep and set it on top of the radiator, and they claimed that by it they experienced the same agreeable feeling that they did from the natural air.

Mr. Blackmore: The question of moisture in a house is governed very largely by the method of heating and by the outside temperature. It is a well-known fact that as the temperature goes down the moisture is precipitated. At zero the air contains a great deal less moisture than it does at seventy; hence if you are heating by the circulation of the air only, as in the case of hot air, you are taking in large volumes of air, say, when the thermometer is at zero, and you raise it up very often in the case of a hot air furnace as high as 200 degrees. Now there is an immediate thirst for moisture by that highly heated air that has been brought from the outside. That moisture must be supplied. If the dry air comes up in the room it will take it from the furniture, if there is any moisture in it, and it will take it from our persons. The moment evaporation takes place from our persons we feel a sense of cold, which explains Mr. Chew's experiment, as evaporation produces that feeling. Therefore it was necessary to supply that moisture to prevent it being taken from the body of the person in the room. Any difference in the moisture of a room heated by steam or by water is due to that same fact, that in a steam heated room you are very often overheated, especially in moderate weather, whereas with a water

plant you probably would not be so, and it is due to the difference in the moisture as well as the temperature in the room that you feel the difference. The zone of circulation around the radiators is at a higher temperature than the average temperature of the room, therefore there is a tendency for moisture to be absorbed to supply the lack in this highly heated portion of the room. Around the hot water radiator the temperature would not be so great, consequently the absorption of moisture would not be so great.

Mr. Chew advanced the question that a direct heated room was not supplied with sufficient moisture. The fact that so many buildings are heated in that manner is some evidence that they are not unhealthy. In your hot air system, where you heat entirely by air, the moisture must be supplied from the outside. In the case of a room heated by direct radiation, the change of air is not so great, and as the change is not great, the call for moisture is not great. If a number of persons are occupying such a room the conditions are changed materially, because each one of them is giving off moisture with his breath all the time; but in an ordinary room occupied by one or two persons, that condition is not noticed. We are not to assume that a room heated by direct radiation is at all unhealthy, or that the air is at all uncomfortable, provided it is only used by a few people. It is when a large number of people are put in a room and the moisture from their breathing is allowed to remain that the air becomes humid. If such a room is heated by indirect radiation, and there is insufficient moisture given in the air, it will take it from the bodies and produce a sensation of cold.

TOPIC NO. 4.

"Does the practice of Consulting Engineers, with respect to heating and ventilating matters, admit of uniformity in prices for services, and if so, in what direction and to what extent?"

DISCUSSION.

The Secretary: This topic was suggested by Mr. George Welsby Scott, a member of our Society in Chicago, who is unable to be present and who has written a short paper on the subject to open the discussion, which I will now read.

SCALE OF PRICES FOR PROFESSIONAL SERVICES.

In paragraph 8 of the charter of the American Society of Heating and Ventilating Engineers we may read that one of the objects for which the Society was formed is the establishment of "a uniform scale of prices for all professional services."

Evidently those concerned with the preparation of the charter were duly impressed with the occasion for making the foregoing one of the aims of the Society, and it may be assumed that they were prompted in this direction by their several experiences. As a matter of fact, few people are so situated that they need not be concerned with the question: "How much shall I charge for my services?" To the many this question is a constantly recurring one, and in its final significance it closely parallels the associated problem rarely ever absent from the mind of the manufacturer and merchant, namely, "How much shall I charge for my wares or goods?"

The occasion for this questioning, regardless of its particular form, is, of course, to be found in the fact that all matters of this kind are inseparable from a primary consideration of two parties; the one offering, or able to give, the desired service, and the other the party who is expected to pay for the service to be rendered. In a secondary degree is the matter of supply and demand in general.

In many of the beaten paths of service—whether manual or intellectual—the scale of charges is more or less arbitrarily fixed by local conditions and the action of combinations; but for so-called professional services the matter is not so definitely arranged. True, custom has set its approval upon certain charges for lawyers and doctors; but are we not all acquainted with various members of these learned professions who receive, at times, fees much larger than those commonly held as standard? And is it not a fact that a large number of them receive fees very much less?

To those who receive relatively small payment, or to those who feel that their services are worthy of higher compensation, the thought of standardizing on a larger basis would, no doubt, prove very attractive indeed. But to the more fortunate ones who, like their equally well favored fellows in law and medicine, are in receipt of relatively large compensation the matter may appear of much less moment.

XUM

At all events, the years of practice in law and medicine have not resulted in any marked degree of uniformity with respect to prices for services in either case; and is it likely that the members of this or of any other engineering society or profession can do better? Apparently those of this Society who framed the charter deemed the matter well within the bounds of probability; and now, after well-nigh ten years of active association it would seem proper to determine the status of the eighth object of the Society's reason for existing and inquire as to the likelihood of its fulfilment.

(1) The question may then be asked: Does the practice of consulting engineers with respect to heating and ventilating matters admit of uniformity in prices for services, and, if so, in what direction and to what extent?

(2) Shall the charge be based upon time and expenses? If so, what shall be the unit of charge?

(3) Similarly, if the charge is to be based upon a percentage of the final cost of the work, what shall be taken as the degree of percentage?

(4) What course shall be taken concerning cases involving much detail work and much expenditure for traveiling and other expenses. This in comparison with less involved and less expensive charges.

(5) And in connection with the foregoing, what shall be said concerning locality; shall engineers in large cities like New York, Philadelphia and Chicago charge the same as, or more than, their fellows situated in smaller cities, towns or villages?

(6) And with respect to assistants: How shall the services of these be graded and charged for?

The President: You have heard the suggestions made by the gentleman who suggested this subject. Are there any remarks on this paper? My own opinion about that matter is that every doctor knows his own value. I think that it is a very poor heating engineer who does not know his. Still I would like to have some of the gentlemen express their opinion on that subject. If none of the gentlemen have any new light to shed on that subject, we will proceed with the next one. Mr. Blackmore, you generally have something to say on most everything that is worth saying. What do you think about that?

Mr. Blackmore: I am not a consulting engineer. I think if

I were I should want to get all I could. (Applause.) I do think this, that there is no profession, that requires the amount of talent, the amount of skill and the amount of energy that it requires to pursue this calling, that is so poorly paid as this one, and I think it is a very laudable object for this Society to do all it can to get proper recognition from the public, to the end that the public may appreciate the value of the heating and ventilating engineer and pay him adequate compensation for his work. The contracting engineer as a rule is not properly paid. The amount of his profit is not fair compensation in a great many instances for the amount of labor and skill that he has to apply to his work. I am glad to see that the consulting engineer is being more highly appreciated and is being paid with a great deal more freedom than he used to be. I do not feel that I can discuss matters of this kind now as freely as I could some years ago, as my business connection with the trade is now more in a commercial than an engineering way. For this reason I feel a little diffident about dipping into purely engineering questions.

The President: Mr. Feldman, of New York, is more directly in that line as I understand it. Perhaps he can give us some suggestions.

Mr. A. M. Feldman, of New York: That is a pretty hard question, on account of the competition. I do not think that any Society can set a certain price or a certain standard of fees. The consulting engineers of New York, so far as I know, are following the plan adopted by the architects, of charging so much per cent. on the cost of the work. The average is 5 per cent.

The President: I always thought in New York they had the very best system of getting the highest prices.

Mr. Feldman: Competition doesn't allow that.

The Secretary: For a number of years our Society had a committee that met in conjunction with the American Institute of Architects on this very line of establishing a minimum price for services, and at the annual meeting of the American Institute of Architects two years ago at Buffalo they decided that any expert service in heating or engineering or ventilating was to be paid for by the client in addition to architect's fees, and I have somewhere their printed schedule, the charges for their services,

which they forwarded to us and also the charge that they were to be allowed which I believe is a minimum of 5 per cent. and as much over as special conditions warranted.

Mr. John S. Brennan: In my experience I have noticed a great many architects make plans and specifications for buildings of all classes. They will then call on some heating and ventilating engineer to make heating and ventilating plans, and instead of his putting his name on the plans the architect puts his name on them. If you ask him why he does that he says, "Well, if I say you do that, those other fellows will knock you and tear it all to pieces." And then, of course, the architect is supposed to get as much as he can from the owner, and if he can get something he will give the consulting engineer what is left after he gets through with the job. And all the points are referred to this architect. He won't say who made the plans for him. I find that a great many men are circumscribed in that way. If they get a chance to make a set of plans they should charge for them and put their name on them for each heating, ventilating or power plant of any kind. A great many vacuum system people make plans and specifications and they sometimes put their names on them, but they don't get anything for them. All they do is to sell their material, and I think it should be left to the heating and ventilating engineer to make those different plans.

TOPIC NO. 5.

"Has the recent discussion of the Plenum System of heating in England added any new and useful information on this branch, or conclusively demonstrated any point?"

DISCUSSION.

The Secretary: One of our members who is present suggested as an addition to that topic, "For perfect ventilation how should the air be introduced and extracted, downward or upward?"

The President: Gentlemen, this is a topic on which there is room for discussion. Some time earlier this year I received a copy of a paper written in England condemning the fan system entirely as a method of furnishing fresh air. This is a re-

port of the Select Committee on Ventilation of the House of Commons. It was sent out early in the year. I sent it to our Secretary and asked him if he could get some of the gentlemen who made a practice of installing the fan system to write a paper in answer to this, but I suppose that our members have all been so busy that they have not had time for that purpose. But the question has been brought up here as a topic for discussion, and we will be pleased if you will use the utmost freedom in discussing it.

Mr. Feldman: I have also a copy of the same paper, and it interested me very much, and that is the reason why I sent in an additional topic for discussion in connection with it. I thought it would be advisable and justifiable to read a few extracts from this paper before the Society here, so as to stimulate discussion. For instance, it says:

"A paper on 'Plenum' ventilation as applied to a hospital in Belfast was read a week or two ago before the Royal Institute of British Architects. In the course of the discussion, a distinguished medical scientist (Dr. Christopher Childs) said:

"'In many "Plenum" installations he had inspected, there had seemed to him grave defects in the relative positions and sizes of the inlets and outlets, and it seemed to him that no definite principles had been laid down as to the most important details. He was not sure that it afforded fresh air for hospitals and schools. They all recognized the necessity for a full supply of pure air. It was easy to test the atmosphere and ascertain the relative proportion of carbonic acid gas in a volume of air, and also to count the microbes; but hitherto analysis had failed at one point—in showing them whence came the invigorating qualities which they all recognized as present in fresh air. These health-giving qualities seemed to him to be lacking in air pumped into a building under a "Plenum" system, and to be present in methods of natural ventilation. The value of fresh, not filtered or pumped, air was obvious in the treatment of cases of phthisis, and all recognized its exhilarating effects. . . . He would not allow that it (the "Plenum" system) was the best for hospitals, as patients needed the stimulus of absolutely fresh and frequently changed air.'"

Then another extract from an American authority, Professor Woodbridge. Undoubtedly all of you know that Professor

Woodbridge has been appointed to examine the Capitol at Washington, and this extract is from his report:

"One would have thought that in these days of higher education and sanitary progress even a schoolboy would know that," as Professor Woodbridge so lucidly explains it:

"The carbonic acid gas yielded by respiration from the lungs and transpiration through the skin is as thoroughly diffused in the warm air currents rising from the body as is the same gas made by the candle or gas flame in the air currents ascending from those flames. That gas when once diffused in air can, because heavier than air, no more settle downward out of the air, and occupy the lower stratum of a room, than the salt, because heavier than water, can settle out of the sea to its bottom."

Professor Woodbrige continues:

"The air in contact with the body or clothing, or expelled from the lungs, made moist and warm by the body's heat and vapor, rises in a current which has a far more rapid rate of upward movement than any descending rate which can possibly be given to the mass of air ventilating a hall."

Now all of you know the American method of ventilation is downward. The fresh air is let in about eight feet above the floor and taken out in the opposite wall near the floor. The English method is the reverse, and Professor Woodbridge seems to believe in that method.

"In downward ventilation the air breathed by floor or gallery occupants must, therefore, be that of the ascending currents of vitiated air reversed by and diluted in the ascending mass of air used in the downward movement. In well planned upward ventilation the individual currents rise to the ceiling and there escape, leaving the floor occupant in the cooler and purer air supplied at the floor, and untainted by the vitiated air which rises out of and away from it. . . . The effectiveness of properly arranged upward ventilation of audience halls is demonstrated in the most recent work of this kind in two theaters and a music hall in Boston."

Now one thing which especially interested me is the reference to Mr. David Grove, supposed to be an American engineer who settled in Germany, and who has designed some of the best public buildings in Germany, including that of the Parliament

Building in Berlin, and who has published a beautiful book illustrating his work. You will see he goes back on his own designs, which is very interesting. He says:

"The failure of the 'Plenum' downward system at the German House of Parliament, Berlin, and the substitution of upward or natural ventilation, and the following extracts from the report of the eminent American engineer, Mr. David Grove, who carried out the work, are very instructive. After two years' experience with both methods, the engineer reports, under date of January 3, 1898, as follows (addressed to K. Hinckeldeyn, Imperial Director of Public Buildings, Berlin):

"In reply to your inquiry of December 25th last, I have pleasure in informing you that the practical working of the heating and ventilating in the new German House of Parliament is such as I felt sure would be the case when preparing the plans. The experience gained during the forty years of practical attention which I have given to the subjects of heating and ventilation has proved to me that no system is so good as the up-draught system, this being a natural one, and, if properly arranged, in every way effective. When I planned the heating and ventilating of the building in question it was stated in the programme that down-draught ventilating must be employed, and that is the reason why I planned that system. At the same time, however, I prepared plans for a system which I felt convinced would be far superior, namely for upward draft, and the practical working of this principle is in every way satisfactory.

"When experiments have been made with down-draught, the air in the room has been found to be very oppressive, especially in muggy weather.

". . . It has for a long time been a fully settled matter in my mind that the only way to really ventilate a room is to let the air take its natural course. During the whole of my experience I have never yet seen a room in which the down-draught system is used where the ventilation has been a perfect one; and, of course, in any rooms where gas is burned, such a system is entirely out of the question."

A still more interesting point is the following, which was stated by a member of that select committee.

"As a significant instance of the change that is taking place

in ideas regarding the respective merits of artificial and natural methods of ventilation, the results of the new Odessa Hospital competition are distinctly instructive, this hospital being one of the largest in Russia, if not in the world.

" As the efficient ventilation of the hospital was considered to be of the first importance, very special attention was given to the subject, the leading ventilating engineers in Europe being invited to submit plans. There were, it is stated, thirty-four schemes in all sent in, nineteen of which were from this country, four being American systems. All were mechanical with the exception of one, which was a natural system. The decision arrived at in respect to these plans was that a mechanical system should be adopted. It was resolved, however, that before selecting any particular plan from amongst the number submitted a committee should be appointed consisting of engineers, architects and others qualified to judge, to investigate into the merits of the respective systems, as applied to buildings in different countries. This committee commenced its labors in Odessa, where several public buildings are mechanically ventilated. It seems that in none of the buildings inspected was the mechanical system found to be in operation, though of the latest construction, the committee being informed in each case that the ventilation was better and less objectionable without it, and it had therefore been disused. The committee paid a visit to this country and made exhaustive investigations into the different systems in use here, including the natural system. Upon the completion of their investigations, the report of the committee was laid before the Municipality of Odessa, who had also received reports from other quarters, the result being that it was unanimously resolved that mechanical ventilation should not be employed and that the natural system (Boyle's) be adopted.

" This certainly speaks volumes as to which of these systems, the natural or the mechanical, was found to be the best when the test of actual experience was applied to them by competent and unprejudiced judges."

" Mr. Addison Hutton, architect, in a lecture on the plans of hospitals recently delivered before the architectural department of the University of Pennsylvania, made a most significant statement as the result of his investigations throughout the states, that with respect to ventilation one point worth not-

ing in regard to this was: Doctors, for a wonder, do not differ in their recommendations for top ventilation, and what is termed ridge or natural ventilation."

I think that is interesting, because there must be something in it anyhow, and let us discuss it.

The President: That is what we are here for.

Mr. H. A. Smith: I have here a later document received from England bearing on this same subject. It is made up of extracts from a report of a debate of the Royal Institute of British Architects at London, on June 6th. It is sent out by our member, Mr. Nesbit, who says in regard to it: " It will be found in the foregoing report that a friend of natural ventilation repudiated certain means that had been adopted to advocate that system and to advertise a particular firm. He referred to a publication issued in imitation of a Blue Book report (which is what Mr. Feldman has been reading from), but his description of it was insufficient. The book was issued in such a way as might lead the casual reader to believe that he was perusing a report of the select committe of the House of Commons; but the matter of which it was made up consisted chiefly of the alleged opinions of persons who were not called before that committee, and the conclusions set forth were opposite to those at which the committee arrived. It concealed its description in the body of the letter press, where only a careful reader would find it."

Now these are some of the quotations here that bear directly on this subject:

" Mr. Pick, after expressing his high appreciation of the general arrangement of the Belfast Hospital which he had visited said: " In hospitals the superficial area and cubic feet of space required to attend properly each patient are necessarily very large, and therefore the requisite changes of air are less difficult to obtain than in such buildings as assembly halls, workshops, schools, out-patients departments and similar places where a large number of people are closely packed together. For these latter buildings I am perfectly convinced that up to the present time no system gives such satisfactory results as a properly designed Plenum System, especially when some mechanical means are arranged for creating a positive extraction of the vitiated air."

And again:

" I think it is not only desirable in such buildings, but almost essential."

Mr. A. Saxon Snell, after a few opening remarks, said: " It was a somewhat unfortunate thing that the question of Plenum ventilation had been canvassed so much in the press by one or two firms commercially interested in the matter. No doubt others like himself had been confronted by their clients with a little Blue Book purporting to be a report of the House of Commons Committee on Ventilation. A little reading of that book would show that it is nothing more than a string of quotations put together, including some remarks of his own, to show that the Plenum system of ventilation was a mistake. There was really no need to study such a book, because so many excellent papers had been read upon the subject during the last few years, notably by the Sanitary Institute and the Institute of Civil Engineers and others."

And later on he says:

" Mr. Harold Griffiths dealt with the charge of the monotony of the air supply, and pointed out that the temperature could be varied under the Plenum system to any degree in the winter, or whenever warmth was required."

That shows the latest we have from the other side.

Mr. Blackmore: It seems to me this paper, of which I have received a copy, and which I read over with a great deal of interest, though I did not take the trouble to study it as I should, is a very partisan paper, and as I always want to know why, I read it to see if there were any real reasons advanced why the Plenum system was not as efficient as it ought to be over in England. The whole paper amounts to a number of assertions and a number of alleged decisions that people came to against the Plenum system, without giving any reasons why they decided against it. Nor does the writer of the paper give any reasons why the natural system, as he calls it, works better than the Plenum. And while it is a good paper to bring the matter to our attention in this country, it shows more than anything else that the condition of the art in England is very much behind. That they are probably blaming a system when the system is all right, but their lack of knowledge of the system is causing the trouble that they have had. I confess I cannot see why, when you are heating a room with warm air and you are

taking out comparatively cool air, you should try and reverse the order of nature and put the cool air out at the top and bring the warm air in at the bottom. I dare say you would mix the air more, which is what he seems to think we ought to do. I think you would mix it up more, but I doubt whether you would get it pure. The object in this country has always been to bring in pure air and take out foul air, but this writer seems to think it is better to mix the air. I suppose for the people outside it would be a little better to mix a little fresh air with it before we put it out, but on no other theory could I accept his reasoning as at all conclusive.

Mr. Feldman: I tried to read only those extracts which dealt with the movement of the air upward. Now I would like the members to discuss this statement: Suppose we want to introduce air for ventilation only, not for heating—heating to be accomplished by direct radiation—and have the air come into the room at 70 degrees F. Now the question is, Is it better to bring it in as we do in this country, namely, overhead, and extract it below, or *vice versa*, as they recommend in England? Mr. Grove does not condemn the Plenum system as a fan system; he merely arrived at the conclusion of reversing the order of letting in fresh air and withdrawing the foul. Now if it was done for ventilation only, I would like to hear the opinion of the members.

Mr. Brennan: About ten years ago in Milwaukee there was an asylum for the insane, possibly two thousand patients there; the building was heated by indirect radiators, partially for ventilation, and by direct radiators. They had the upward ventilation. In going through those different rooms, the patients being crazy people, the smell was very nauseating in almost every room. They decided to change and put in the Plenum system for ventilating purposes only. They put in two fans for three buildings, and had one fan at each end. There were three buildings in a row, and they had it arranged so that if one fan should break down they could use the other temporarily for the other two buildings, and since putting that in you could go to any room and notice the difference, just by walking through the room, it was so much better and purer in every way, and I think that a great many will bear me out by their personal experiences in different buildings that are ventilated

by natural draft and those that are ventilated by fans, by having the heat come in seven or eight feet above the floor and having a register taken out near the floor. Now the city of Milwaukee has all its schools warmed by direct radiators and ventilated by fans run by gas engines or motors, and they change the air in the class rooms every minute, or fifty cubic feet per scholar per minute, and in the halls and corridors and toilet rooms every ten minutes, and you can notice the difference immediately by just walking through the rooms; the air is pure and fresh.

Mr. William C. Dean, of Ithaca, N. Y.: I received a copy of that pamphlet last winter, and was very much surprised to hear any one decry the fan system. I talked with Professor Carpenter about it, and he laughed and ridiculed the thing. He says that has an official look, but the only natural system that anybody advocates there is the Boyle system. This man Boyle claims to have a patent on a natural system of ventilation. He sent Professor Carpenter an elaborate catalogue, and he says that all there is of this thing is this man Boyle trying to build up a system by giving the fan system a black eye; that is all the thing amounts to.

TOPIC NO. 6.

"Do the increased benefits of fan over gravity systems offset the operative necessities?"

DISCUSSION.

Mr. F. K. Chew: Mr. President, I feel that it is only lack of knowledge in reference to how to apply fans that prevents their wider use, and I am satisfied that some of the men here who are interested in the fan side could give, without very much trouble, information that would be very useful to some of the other members.

Mr. Brennan: Regarding the fan system, I know that there have been several fan systems in the West, and when they got 20 degrees below zero, which they hadn't counted on, they started up the fan a little faster, and instead of heating the building, they simply pumped more air into the building, and changed the air a great many times. Now a fan is all right for ventilating purposes, and in some cases it is all right to heat up large foundries and places where they can use the air over

and over again, where they exhaust enough to offset the nauseating air that is made in the building. In a great many cases fans may be used; for instance, in this building here a fan would not go very bad, if they would push a little of this air out and let a little fresh air come in. The fan would be all right for ventilating.

The President: I would like to have some of the other gentlemen talk on this subject, but I understood from the talk of Mr. Snyder, of New York, that they made a practice in all their schools there of using a fan supply for bringing in the quantity of air required for the purposes of ventilation, and they depended upon the direct radiation more for the heat, but the air that is used is all brought in by the fan system, and that is exclusively for ventilation.

Mr. Frank K. Chew: At dinner Mr. Shanklin, of Charleston, W. Va., told me he was about to remodel a system. He had a fan in connection with hot air furnaces. Possibly Mr. Shanklin would be willing to give us some information about that particular plant.

Mr. Munroe: I have something that I desire to say. I have had some little experience in ventilating school buildings in the last three years. Down at Baltimore there has been quite a discussion for a number of years past as to the kind of heating to be used in public school buildings. Our new mayor and the city officials there determined on a hot blast or fan system, and it was the good fortune of the concern I was with to land the contracts for heating seven different school buildings. There have been seven school buildings erected in Baltimore in the last three years. It fell to my lot to design the heating apparatus in them. Specifications were gotten out by the building inspector, but they simply said that a fan should be used in connection with high pressure steam heating and tempering coils. That was sufficient to design a heating apparatus from. We put in one plant after another and they each worked very successfully with an intelligent engineer to operate them, but in three cases after we had turned the plants over to the city engineer there came constant complaints as to the operation of the plant. The fact that we had operated it, before we turned it over, on a ten-day test satisfactorily, made it conclusive to the building inspector that the job was all he

had anticipated, and the firm had a three-year guarantee and bond to make the plant good. The consequence was they employed this firm to go back and put their engineer on the job and operate it for a week. There were five buildings at one time, and they put three men on the three of them, and the next week put two men on the other two, and the results were exceedingly gratifying. We manipulated the apparatus in such a way that every room was regulated within two degrees, without any mechanical automatic temperature regulation; only hand regulation by means of levers attached by chains to mixing dampers at the base of the flues. The fans were operated at the proper number of revolutions to give sufficient air to fill every room in the building four times an hour. The trouble that the city engineers experienced was directly from laziness. They did not want to keep the steam pressure up, and they thought they would run the engines with forty pounds of steam, and the moment they dropped the steam pressure to forty pounds, the revolutions of the fan dropped below the normal, and the consequence was that certain rooms in the building would get the air and certain others would not get it. That is to say, there was a suction out of some of the rooms and into the others. That was immediately overcome by speeding up the engine and running the fan to the proper number of revolutions to deliver the amount of air figured on to every room in the building, and it turned out to be entirely satisfactory in the end. Now we know fans are here to stay. They are not only good for ventilating, but they are good for heating. There is no direct radiation in any of these schools; it is all indirect and all in the basement, and there was no trouble in heating the entire building with this kind of apparatus. The registers for the inlet of the hot air and the outlet or vent were in every case located side by side one above the other, and the circulation would be across the room and back, while sometimes there was a pretty strong current of air; it was not objectionable, because the hot air was overhead, and after the room became heated up it would scarcely be noticeable—if there was a draft across the floor it was about 70 degrees F., and so it was not objectionable.

Now as to ventilating a building with fans, you can scarcely use too many fans in ventilating large buildings. The Belvidere

Hotel, Baltimore, has just been completed, and it has in it eight ventilating fans. There are no heating fans there. The building is heated by direct and by indirect radiation, but there are eight ventilating fans, with galvanized iron vent ducts, properly designed. The plant was designed by a member of our Society, who unfortunately is not here—Mr. Henry Adams, of Baltimore. Where fans are used properly, better results cannot be obtained otherwise. My idea is to extract the vitiated air from the building, and the fresh air will get in at other points. As I said, fans are here to stay, and we must learn how to use them and use them properly, wherever we can.

TOPIC NO. 7.

" Is there any system of heating and ventilating schoolrooms by means of pressure or exhaust fans, or both, which will not be thrown out of balance by opening windows ? "

TOPIC NO. 8.

" Is it possible to positively change the air in a building a given number of times per hour ? "

DISCUSSION.

The Secretary: I think perhaps in opening that discussion it will be well for me to read a short extract from the law on heating and ventilating school buildings, which has been passed by the Legislature of the State of New York and is now in effect, through the efforts of a committee connected with this Society. The clause that I would read is this:

" Such commission of education shall not approve any plans for the erection of any school building or addition thereto unless the same shall provide at least fifteen square feet of floor-space and two hundred cubic feet of air space for each pupil to be accommodated, in each study or recitation room therein, and no such plan shall be approved by them unless provision is made therein for changing at least thirty cubic feet of air every minute per pupil, and the facilities for exhausting foul and vitiated air therein shall be positive and independent of atmospheric changes.

Mr. Macon: I believe some one said that was the first state that has passed a law regulating the supply of air in school rooms. Is there not a law in Massachusetts on that subject?

Mr. Smith: It is a suggestive law—a permissive law.

The Secretary: There is no mandatory law. The district police there have the power, the same as the board of health has in any other state, to close a building that is not, in their judgment, properly heated and ventilated, but there is no law compelling anything of that kind. Along those lines, Mr. President, I would like to relate an incident in connection with the heating and ventilation of school buildings. The work of heating some hundreds of buildings in a certain city had fallen to the lot of the steam fitter, and he was happy. But he became disturbed when a hot air furnace concern who make a specialty of heating school buildings arrived upon the scene and condemned the board of education for their methods, and suggested the only system that should be adopted for the heating and ventilating of school buildings. Their representative talked so well that a new school, the largest and best school in the city, was given into his hands. The board of education built the heating plant and he got the money for it, and amongst other things in the opening of the school he circularized the city pretty well and got a large audience there at the opening, and he said this was the only school in the city where the air was being changed six times an hour. Everybody was happy except the steam fitters. One of them, with a long head and a roll under his arm, requested the janitor to bring him a coal scuttle. He set it in the center of the room, undid his parcel, which contained some tar paper. He opened up the tar paper and put a match to it. Immediately the black smoke rose and filled the room. He said, "Now, gentlemen, the air in this room is being changed six times an hour. In ten minutes all of this smoke will be gone." They sat and sat and sat, and the ten minutes went on to twenty, and the twenty to thirty, and the thirty to forty, and the smoke, while it was getting diluted and thinned down, was still in the room at the end of an hour. (Applause.)

TOPIC NO. 9.

"Is it good practice to design an especial heating system by direct radiation to take care of the heating when outside temperature air is above, say, 30 degrees Fahrenheit, and supply the additional amount of heat by a fan when the temperature is below that point?"

DISCUSSION.

Secretary Mackay: It does not seem to me that that would be good practice. If there is any object in using a fan it is for the

purposes of ventilation. If we need ventilation at a low temperature we need it also at a high temperature. It would be better in my judgment to heat the buildings in moderate weather with a fan and supplement it with direct radiation. In that way we get ventilation at all times and an extra amount of heat in cold weather.

Mr. Brennan: I think that would be a first-class apparatus for a shop or residence or any kind of a building; to use direct radiation for heating, and the indirect radiation or fan blast for ventilation. If the temperature were below zero it would require less direct radiation and more blast system, and if it were very cold it would require more direct radiation and less ventilated air. You change the air just as many times in cold weather as you do in warm weather, but you would require more direct radiation in cold weather than you would in warm weather, and in warm weather you could use the fan for changing the air where there was no radiation needed at all.

Mr. Feldman: The practice in shop heating is to use the air over and over again. They don't take in fresh air. That is the reason that ventilation by fans in shops is considered cheap.

Mr. Brennan: There are some shops that are heated in that manner by using fans, churning the air over and over again, and not taking fresh air, but there are a great many that do take fresh air and distribute it around among the different shops. Take large foundries and buildings of that class, where they want to heat it cheap, and they don't care anything about changing the air at all. In that manner they churn the air over and over. But in large manufacturing plants they take fresh air from outside.

Prof. James D. Hoffman: It is a very common thing for shops in our part of the country at least to heat by means of fresh air. I think in few cases is the air churned over and over again. The fact that they can in almost all cases use the exhaust from their engines as heat for the coils makes it practically a cheap system. Where condensers are not used, they merely turn the exhaust steam into the coils for warm and medium cold weather, and in very cold weather a little live steam. While I believe it is slightly more expensive than the direct system the circulation of fresh air makes it highly desirable. As I understand the question that was read by our Secretary, it means two separate

systems, a direct steam system and a blower system. The direct steam system to be used at a 30-degree outside temperature and the blower system below that; am I correct?

The Secretary: Yes.

Professor Hoffman: My experience has been that the blower system is a good thing for shop service at all times, cold or warm.

Mr. Brennan: Regarding the blower system at all times, there would be some times when, if the thermometer were 23 or, say, 35 below zero, it would be almost impossible for a man to keep up steam to heat those buildings by taking air from the outside. I have known of cases of schoolhouses where they have had the blast system almost entirely, and the engineer would speed up the fans and try to heat the building that way, and put on four or five extra firemen, trying to keep heating the building. He was changing the air more times, and killing the firemen, and burning a lot of coal. If the apparatus is put in in the first place large enough to overcome those cold temperatures outside, it would be too expensive to operate, and my opinion is that to successfully heat a public building it should be heated with direct radiation, together with a certain amount of the blower system added to it.

The President: I think there is no question at all, but that is the universal practice now in all large buildings, either public or private, to use about two-thirds direct radiation.

The Secretary: It is also found to be of advantage in school heating systems from 4 o'clock in the afternoon to 9 in the morning on week days, and from Friday evening until Monday morning every week, and through the Christmas and New Year's holidays. They can maintain sufficient temperature to heat the buildings thoroughly, keep the plumbing from freezing by direct radiation, and not operate the fan at all. Where they operate fans for ventilating purposes, after school is closed, sufficiently long to extract all the vitiated air, they find it is an item of economy in running the plant.

Mr. George D. Hoffman: I had a little experience on the question, "Is ventilating expensive?" We had a schoolhouse in a little town I lived in several years ago that was heated by direct hot water heat. There was no great trouble in heating the school at all times, but it had absolutely no method of venti-

lation. They came to me and wanted me to go on the school board. I told them I would on one condition, that if I was elected the schoolhouse was to be ventilated; if I was defeated that would signify that the people were satisfied with the present method of heating. I was overwhelmingly elected. I got fifteen votes, which was all that was cast in the town. (Laughter.) I put in a ventilating plant with a two-inch fan and a 32-inch fire pot furnace, running the fan by means of a water motor. Now the point that I want to bring out is that we apparently ventilated that school thoroughly. I never put any real test on it, but the fact was that scholars who, previous to the ventilation, were continually coming home with headaches and complaining about feeling unwell, absolutely had none of that trouble after the ventilating apparatus was installed. Now the fact that I want to bring out is that the fuel consumption was absolutely the same. We ran the fan all the time that the school was in session, shutting it down and allowing the furnace and the hot air apparatus to heat the schoolroom during the hours between the letting out of the school and beginning next morning. The hot water apparatus was simply used as an auxiliary and run during cold weather, so that the furnace was doing most of the work, and yet the fuel consumption, with at least a half way system of ventilation, was identically the same as it was when it was heated simply with hot water.

Mr. Brennan: There are some doubts in my mind as to that fuel bill being the same. The weather might have been different, or something, because if he changed the air in those rooms a certain number of times each day there certainly must have been more heat units used to heat that air.

Now I would like to ask some of the members if they have any method of determining whether the air is changed in those different rooms—I know there are some ways of doing it by holding an anemometer or an air motor over the inlet air register, and figuring out that you have so many cubic feet per minute going into that class-room, and the supposition is if it comes in it will go out; but I would like to ask if the air is changed in the room, or if it comes in one pipe and goes out of another, holding a good deal of the old air in there yet?

Mr. Jones: In reply to the gentleman who has just sat down I would say that I have had some experience in heating and

ventilating school buildings with hot air, not with steam or hot water; but my experience in heating the normal school in Wauseon, O., would answer that question. We there put in enough warm air furnaces to heat the schoolroom, which had eighteen rooms, and for each room we supplied an inlet of air sufficiently large to fill the room once every twenty minutes, with an outlet sufficiently large to take that amount of air out of the rooms. The blackboards were along the north side of the schoolroom, while the heating and ventilating register was about the center of the east side, and would be white with chalk dust where it lodged on the bars of the ventilating face, which would indicate that the air was being drawn out of the room other than directly from the register to the ventilator. I simply mention that to show that the air is drawn from the different parts of the room and from the lower part, or near the floor.

The President: Was there a blackboard on the opposite side of the room?

Mr. Jones: No. There was none on the opposite side.

Mr. Collamore: If there are any consulting engineers here, they undoubtedly have had some experience with public boards where the appropriations were somewhat limited, and they are not always able to install the ideal system. In the school buildings here the idea has been to use the blower system for heating and ventilating the schoolrooms, using direct radiation in the halls, toilet rooms and principal's office, and figuring the radiation so that the halls can be heated to a very reasonable temperature, even as high as 75 degrees, the idea being that at times when the plant is not in use the direct radiation can be used to take the chill off the building. In that way we are able to accomplish both results to a reasonable degree without the large expenditure necessary for the combined systems.

As to the matter of the cost of heating and ventilating, I was somewhat surprised to hear the gentleman remark that the fuel bill in this school which he refers to was no greater when the rooms were ventilated than before. In collecting some data on that subject recently for schoolhouse work, the amount of coal burned seemed to run for a system of direct radiation about four tons per room, whereas with the ventilating system using fans it seems to run somewhere about eight or nine tons, or nearly double, the gravity furnaces requiring just about as much as the fan system.

The Secretary: I made the remark about the school buildings, and in doing so I did not want to convey an impression as to the right or wrong of it, but merely to say that it is the practice in the city of New York, where they spend more money for the heating and ventilating of their school buildings than in any other city in the world, and the necessity, and the results obtained there were largely the means of having our state law passed in New York.

Now in Mr. Hoffman's remarks there about the amount of coal, it would seem that would be so, provided the hot water heater which was originally in the building was small for the building and had to be pushed when only heating it in extreme weather. Then he supplemented his grate area by putting in a furnace with a 32-inch grate—he had that much more capacity for generating and introducing heat—and as a result the hot water heater which had formerly been used for heating the building was only used as an auxiliary and could be run at a much lower temperature, and as a result would absorb a greater amount of the fuel used in the heater, and I think his saving in the ventilation was what he lost when he was heating by hot water and allowing the gases to pass up the chimney at a high temperature.

Mr. George D. Hoffman: Mr. Mackay just took the words out of my mouth. When he spoke about that I was just about to rise and say that the hot water heater was utterly inadequate to the building, and in cold weather it had to be crowded to its utmost capacity, and in fact the building was hardly warm enough to stay in in anything like zero weather or below, while after we put in the fan system there was no trouble whatever in heating the building.

Mr. Brennan: The point that I made was this, that it cost more money to heat a building by indirect radiation or by the blast system than by direct. What I meant was that he used more heat units after he had his fan going than before, and whether, if he was not using his heating apparatus economically, he was doing more heating after he put the fan in than he was before. He was heating more air, consequently he was using more heat units.

Mr. George D. Hoffman: Mr. Blackmore made the statement a few moments ago that it was clearly demonstrated by a test

made by himself and Professor Carpenter that it was impossible to take the heat units off an iron plate as fast as the fire would transmit them. Now it stands to reason that that being true (I am willing to admit it is true), that the more air we can bring in contact with that surface, the more heat units we are going to absorb, and the less number of heat units we are going to pass into the atmosphere through the chimney. I think that is one reason why a blast system is more economical, as I have always understood that it was, than a system of direct radiation, simply because you are bringing more air in contact with your heating surface, thereby absorbing the heat that much faster.

Mr. Brennan: I would like to have some of the members express their views regarding a steam boiler run at low pressure for heating purposes, say from two to five pounds, and the same sized boiler under the same conditions run at high pressure, say fifty to seventy-five pounds of steam, and reduce that pressure to the same conditions as the low pressure heating apparatus, using a pump or some other means of returning the condensation back, using both apparatuses as a heating apparatus, which could you generate the most heat from, or which would supply the greatest amount of radiation, the high pressure or the low pressure?

Mr. Blackmore: I might start a little discussion on that subject. I don't think there would be any difference in the efficiency of the boiler at all, providing the low pressure boiler was properly piped and the conditions were good for low pressure. We would do no good by increasing the pressure on such a boiler by putting on a low pressure valve and introducing a return pump governor. If any difference, there would be a slight loss, due to the fact that in carrying a higher temperature the water in the boiler would not be quite as good an absorber of the heat in the gases of combustion as they pass through to the chimney. But in an actual test I don't believe any difference could be discovered, it would be so small; if, however, the apparatus was put up improperly for a low pressure job with small piping, an advantage might be obtained by increasing the pressure and making a mechanical return.

Mr. Munroe: I would like to say one thing: To get any more capacity out of that boiler, you would immediately have to increase the grate surface in order to run it at high pressure.

Then you increase the capacity of your boiler. The boiler would not develop any more power unless some change were made in it. You could not run that boiler designed for low pressure work at high pressure work unless you proposed to burn more coal in that grate.

Mr. Brennan: The point was whether they could do it, not how much coal they would burn. Some people say you would have a better combustion at low pressure; while the low pressure man would say that he was absorbing more heat units because the water was colder. It might have been colder and come in contact with colder water and *vice versa*. The question was could he develop the power more, irrespective of the amount of coal burned?

Mr. George D. Hoffman: I guess about all any one can do on this subject is theorize. Now when we reduce the pressure of steam, the temperature is reduced by reason of its coming in contact with the air that is inside the pipe, and the result of that would be, looking at it from a theoretical standpoint, that there would be less moisture in the steam reduced from a pressure of sixty or seventy pounds than there would be from a low pressure steam just simply carried into the pipe and circulated in that way. Mr. Brennan was talking yesterday with Mr. Davis, of the Warren-Webster system. I happened to know about the job myself personally, because the job in question was right across the street from our office in Chicago. That building was originally piped for low pressure steam. The Warren-Webster people got after it and they got the contract. The result was that the system was not changed from a low pressure system to a high pressure system, and the pumps run by the action of the steam generated from the boiler itself, but an auxiliary boiler was put in and the original plant was left as a low pressure job. Mr. Davis made a statement to Mr. Brennan and myself yesterday that on this job they had two large pumps, and were utterly unable to get the circulation through the system from the low pressure boilers. They afterwards changed and turned the boiler into a high pressure boiler, and put a reducing valve on the main, with the result that they were able to dispense with one pump, and the building was entirely heated, and the boiler had no trouble at all in furnishing the steam.

XUM

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XUM

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XUM

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INDEX TO VOL. X.

PAGE

Address of the President 8

Aylesworth, Dr. Geo. M., Paper CXXIV., *Test of a Hot Air Heating Apparatus Using Radiators Instead of Registers* 101

Barron, H. J., Papers CXXI., CXXX., *A Review of Some Heating Literature*, 48, 216; Disc. on The Metric System, 85; on Hot-air Heating Apparatus, 112; on Ventilation 188

Battery System of Warm Air Heating, Paper CXXVII., by C. E. Oldacre 137

Blackmore, J. J., Disc. on The Metric System, 88; on Ventilating Residences 191

Carpenter, R. C., Paper CXXVI., *The Necessity of Moisture in Heated Houses*, 129; Disc. on Heating Greenhouses 182

Cary, A. A., Disc. on Ventilating Apartment Houses 183

Chew, F. K., Disc. of Hot Air Heating Apparatus, 112; on Heat Transmission, 124; on Ventilating Houses 249

Combination Hot Air and Hot Water Heating 172

Education of Heating and Ventilating Engineers, Paper CXXXI., J. D. Hoffman 222

Extended Heating Surface in Furnaces 125

Flues for Warm Air, Proportioning 176

Formulæ for Furnace Heating 251

Furnace Heating (see also Heating by Warm Air) 235

Furnaces, Hot Air 246

Gravity System of Ventilating 282

Greenhouse Heating 177

Harvey, A. J., Disc. on Heating Greenhouses 179

Hauss, Charles F., Paper CXXIII., *The Metric System*, 80; Paper CXXV., *To Figure Heating Work Accurately. Losses in British Thermal Units for Various Surfaces* 114

Heat Transmission, Coefficients of 114

Heating Literature, Review of Papers CXXI., CXXX., by H. J. Barron 48, 216

Heating Surface, Extended, Disc. on 126

Heating, Warm-air, Advanced Methods of, Paper CXXXII, by A. O. Jones 235

History of the Society, Paper CXX., by S. A. Jellett 35

Hoffman, Geo. D., Disc. on Furnace Heating 246

Hoffman, Jas. D., Paper CXXXI., *The Education of Heating and Ventilating Engineers* 235

Hot Air Heating Apparatus Using Radiators Instead of Registers, Paper CXXIV., by Geo. M. Aylesworth 101

XUM

PAGE

Hot Water Heating in the Schioldann Institution, Copenhagen, Denmark, Paper CXII., by CAPT. A. B. RECK..... 55
HOYT, A. T., Vacuum System of Heating by Water..... 257
Humidity, see also Moisture.....153, 264
JELLETT, S. A., Paper CXX., *A Short History of our Society*..... 35
JONES, O. A. Paper CXXXII., *Advanced Methods of Warm Air Heating* 235
KENT, WILLIAM, Disc. on The Metric System, 93; on Coefficients of Heat Transmission, 119; Experiment with Schlicht System, 158; on Water Pans in Furnaces..... 161
KINEALY, J. H., Disc. on The Metric System, 86; on Transmission of Heat 120
Legislation, Report of Committee on..... 22
MACKAY, W. M., Secretary, Silver Cup Presented to, 31; Disc. on Heating Greenhouses..... 180
Metric System, Paper CXXIII., by CHAS. F. HAUSS..... 80
Metric System, Vote of Society on..... 13
Moisture, Necessity of, in Heated Houses, Paper, by R. C. CARPENTER. 129
OLDACRE, C. E., Paper CXXVII., *The Battery System of Warm Air Heating* 138
Péclet's Coefficients of Heat Transmission..... 119
Pipe Joints..... 198
Plenum System, Alleged Failure of..... 274
Proceedings of the Annual Meeting..... 7
Proceedings of the Semi-annual Meeting..... 109
RECK, CAPT. A. B., Paper CXII., *Description of Hot Water Heating Apparatus in Copenhagen, Denmark*, 55; Disc. on The Metric System, 92; on Ventilating Residences..... 190
RICHARDSON, D. S., Disc. on Water Pans in Furnaces..... 155
Report of the Board of Governors..... 13
Report of the Committee on Compulsory Legislation..... 22
Report of the Committee on Tests..... 26
Report of the Committee on Uniform Contracts..... 15
Report of the Secretary..... 10
Report of the Tellers of Election..... 19
Report of the Tenth Anniversary Committee..... 16
Report of the Treasurer..... 12
School Houses, Ventilation of.....188, 283
SNOW, W. G., Disc. on Hot Air Heating Apparatus, 109; on Heat Transmission in Furnaces..... 121
SWITZER, W. H., Disc. on Battery System of Warm Air Heating, 152; on Water Pans in Heaters..... 153
TOPICAL DISCUSSIONS, ANNUAL MEETING:
No. 1. Should it be considered the work of the Society to secure records of different types of heating systems?..... 162
No. 2. Could the interests of the purchasers of heating systems be conserved by a closer relation between the heating engineer and manufacturer of specialties?..... 169
No. 3. Can a constant relation be established between the areas of cold air ducts, hot air flues and the radiating and heating surfaces in indirect heating?..... 170

PAGE

No. 4. What is the prevailing practice in proportioning water heaters in hot air furnaces to the work to be done?..... 172
No. 5. Are all types of sectional cast iron boilers adapted for steam heating?..... 175
No. 6. Has experience demonstrated the relative superiority of iron or steel pipe as regards durability in heating systems?..... 176
No. 7. Has latest practice demonstrated the advisability of using smaller sizes of pipe in hot water systems in greenhouses?..... 177
No. 8. Has the need been demonstrated of some method of ventilation in connection with accepted systems of heating?..... 183
No. 9. In making screwed joints, is it better to use some compound or make them up iron to iron with no compound?..... 198

Topical Discussion, Semi-Annual Meeting:

No. 1. Are the commercial demands upon the time of our members the only hindrance to the presentation of tabulated or descriptive experience of their work?..... 255
No. 2. Vacuum systems of steam heating..... 255
No. 3. Can the effect of humidity upon the sensible temperature of a room be modified by ordinary heating and ventilating apparatus 264
No. 4. Does the practice of consulting engineers in heating and ventilating admit of uniformity in prices for services?..... 270
No. 5. Has the recent discussion of the plenum system of heating in England added any new and useful information on this branch? 274
No. 6. Do the increased benefits of fan over gravity systems offset the operative necessities?..... 282
No. 7. Is there any system of heating and ventilating school-rooms by fans which will not be thrown out of balance by opening windows? 285
No. 8. Is it possible to positively change the air in a building a given number of times per hour?..... 285
No. 9. Is it good practice to design a heating system by direct radiation for heating when the outside temperature is, say, 30 degrees F., and supply additional heat by a fan when the temperature is below that point?..... 286

Transmission of Heat in Buildings. Paper by C. F. Hauss..... 114
Transmission of Heat in Buildings. Table by A. R. Wolff..... 128
Transmission of Heat in Furnaces..... 120
Vacuum Steam Heating Systems..... 255
Vacuum Water Heating, by A. T. Hoyt..... 257
Ventilation of Houses..... 183
Ventilation, Upward or Downward..... 274
Water Pans in Heaters..... 129, 153
Wolfe, W. F., Disc. on Hot Air Heating Apparatus..... 107
Wolff, Alfred R., Diagram of Transmission of Heat in Buildings... 128